JUL 20

PIPE LINE INDUSTRY

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CONSTRUCTION • OPERATIONS • MAINTENANCE

Station Design

For a collection of valuable information on modern station design, don't miss . . . . . Pages 20-38

Hot-Tap Under Water

Here is the solution to one of the problems which will face pipeliners operating in the Gulf of Mexico . . . . . Page 40

'Mole' in Action

One company used an instrument adapted from oil well survey equipment to pin-point a submerged line . . . . . Page 46

Turn page for additional contents and a Quick Review of this issue

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a hundred mile investment...

is worth protection

And Kontol offers the best. Whether your pipe lines are measured in miles, hundreds of miles or thousands of miles – corrosion, fouling and *scaling* are potential hazards. Kontol inhibitors offer proved protection against corrosion; they also have effective detergent characteristics which have demonstrated outstanding line-cleaning action.

A typical case in point was a 385 mile, 6" product line in the eastern area, originally designed to handle 12,000 bpd. After preliminary scraping to remove loose scale, Kontol 118 was injected at the rate of one gallon per thousand barrels of throughput. Shown below is a summary of the results obtained.

LINE	"C" FACTOR BEFORE KONTOL*	AFTER KONTOL**
Pump Station 2 to 3	132	138
Pump Station 3 to 4	135	142
Pump Station 4 to 5	138	145
Pump Station 8 to 9	118	135

*Scrapers only **Kontol and scrapers

THROUGHPUT INCREASE: 720 barrels per day
ESTIMATE SCALE REMOVED: 16 tons

After the line was cleaned, Kontol 77 was injected into the line to control acidic corrosion and oxidation. This treatment will also aid in maintaining a high "C" factor.

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PIPE LINE INDUSTRY

CONTENTS and Quick Review

November, 1955 Vol. 3, No. 5

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

Ebullition Cooling Is Paying Off

☐ By letting water boil in the engine jackets, cooling equipment is less costly, the engine operates at a higher and less variable temperature, and the efficiency is increased. Here is the operating experience of a company which has been using this type of cooling for some time.

By G. O. Bates, J. E. English and G. M. Franklin Page 20

Alaskan Line Stations Designed For Weather Extremes

☐ How would you design a station to handle fluid temperature variations from 42° F. to 102° F.? Then, think, too, of operating temperature ranging from —80° F. to 100° F. Here is how these special design problems were solved on the Alaskan products line.

By Hugh Robinson.....Page 24

Why Not Operate Compressor Cylinders Without Water?

☐ Compressor cylinders operating below a compression ratio of 5 or so do not need cooling water, according to tests and operating experience at several compressor plants. Sometime the jacket water does more harm than good. Two years of operation have shown that there has been no measurable loss in gas-handling capacity and no increase in cylinder wear.

By J. L. Gallagher and H. W. Evans...Page 28

Fuel Cost Charts for Engine Selection

☐ Fuel consumption is perhaps the Number 1 consideration in selecting engines for pipe line use. Here is a good way to determine just which fuel would be best for a particular installation.

By Volney M. Holmes.....Page 31

How Far Have We Come in Pump Station Automation?

☐ An industry-wide survey shows that oil pipe line companies are heading toward automation in a big way. This is especially true in new installations. A look at the present status of the industry, gives an idea of future trends.

By E. B. Turner.....Page 32

How a Line Was Tapped Under 22 Feet of Water in the Gulf

☐ A solution has been found to one of the problems which will certainly face pipeliners who operate in the open waters of the Gulf of Mexico. A successful hot-tap was made on a line 22 feet below the surface of the water. It was made in a hinged bell which closes around the line like a clam bucket on a dragline. And the operation was not expensive!

E. E. Campbell.....Page 40

Gyroscopic 'Mole' Surveys Pipe Line Under Mississippi

☐ For future information, Texas Eastern Transmission Corporation wanted to know exactly where the pipe was buried under the Mississippi River on a recently-completed New Roads, La., crossing. Here's how the job was done, using an instrument adapted from oil well survey equipment.

By Melvin A. Judah.....Page 46

How to Calculate Turbulent Two-Phase Flow

☐ With more and more two-phase lines being laid in offshore fields, it is more important than ever for the pipe line engineer to be able to predict the performance of a line carrying both gas and distillate. Here are the results of 264 experimental runs where the flow is in the turbulent stages.

By J. M. Chenoweth and M. W. Martin.....Page 50

Engine Doctor.....Page 39

New Australian Line Carries Coal Gas.....Page 49

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Anybody seen this man?

We're looking for a certain fellow on the sunny side of 40. You'd consider him a personable sort, though he doesn't display his dentures at the drop of pun. He's got a lively curiosity, likes to travel, and he likes people. He went to college . . . studied engineering . . . but he didn't stay there so long he became a campus institution. Someone who has some pipe line experience. He has a nodding acquaintance with a typewriter. Not necessarily a polished writer, you understand. Just a fellow who can put one little word after another and come up with something a pipeliner will like to read.

Have you seen this fellow? Well, if you happen to run across him, tell him to get in touch with Warren Baker, the foreman on this spread. Warren wants to offer him a job. The complete name and address is Warren L. Baker, Editorial Director, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1.

PIPE LINE INDUSTRY published every month. Entered as second class mail matter July 9, 1954, at the post office at Houston, Texas, under the act of March 3, 1879.

The API Serves You

The annual meeting of the American Petroleum Institute will convene in San Francisco in mid-November. Those attending will appreciate that it is a big affair. This will be impressed upon them by an attendance in excess of 6000, and by their contact with some of the numerous committee meetings, group sessions or general sessions.

However, even these people are not likely to realize the tremendously varied and wide scope activities of the Institute. Few people other than the 130 oil men who make up the Board of Directors actually realize the scope of the Institute's activities or the size of the organization required to administer and direct its vast operations. This is because so few oil men have an opportunity to come in contact with more than just a small portion of the Institute's activities.

Because so few actually have an understanding of the Institute's over-all activity and operations, the forthcoming annual meeting constitutes an excellent time for oil men everywhere to stop for a few moments and think about the many ways the API attempts to serve the oil industry.

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The Institute is the industry's largest forum, information bureau, and technical clearing house.

In addition to the annual meeting, many other meetings will be held by the various divisions and departments of the Institute during the course of a year. These will range from national to district and even local level. More than 150,000 oil men will attend these various API meetings during 1955, although attendance at any one of them will seldom exceed 1500. Many of them will have only a few hundred in attendance.

These meetings, however, constitute only a part of the API work. Most of the Institute's activity is done at committee level, with the membership made up of men from the industry. For example, approximately 160 separate committee meetings will be held during the annual meeting in San Francisco. Many other committee meetings are held at other times during the year, and much is accomplished by correspondence with committee members throughout the year.

It is impossible to describe all the API's activities. Essentially, they might be classified as in the fields of equipment standardization, design and care of equipment, all phases of engineering and technology, fundamental research, safety and fire protection, waste disposal, nomenclature, metallurgy, corrosion control and prevention, all transportation phases, fuels and lubricants, agriculture, highway construction, aviation, vocational and personnel training, education and public relations, finance, accounting, statistics, petroleum reserves, taxation, legislation, and government regulation.

The API setup, as previously mentioned, consists essentially of committees and their subcommittees. So as to have a workable organization that can handle all these matters in an efficient manner, the institute is divided into executive functions; four operating divisions of production, refining, transportation and marketing; and a number of service departments, such as the Department of Information, the American Petroleum Industries Committee, the Department of Statistics, and the Department of Technical Services.

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A big staff of paid personnel is required to handle all the affairs and activities of the Institute, although so much of its work is done by volunteers from the industry serving on numerous committees.

Therefore, the Institute itself constitutes a big business operation. It has a total of 325 paid employes at its offices in New York, Washington, Dallas, Los Angeles, and in the field offices of the Oil Industry Information Committee and the American Petroleum Industries Committee. Its annual budget for all activities now reaches $7 million.

The paid staff of the API works mainly in an administrative capacity, working as a service organization for the Board of Directors and its Executive Committee, and for the Institute's many, many divisional and departmental committees. Each of the Institute's four divisions and different service departments is headed by a director, and the necessary staff of assistants and clerical help.

Don't think of the API as performing only the operations with which you are familiar. Nine chances out of 10 it is engaged in many activities that you do not know about.

Warren L. Baker

B : 601468

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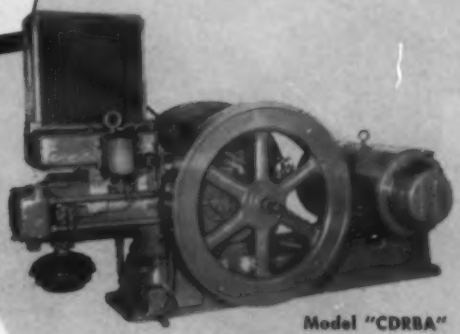
for your microwave communications



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"ADRBA"	Diesel	1,500	5.5	1,800	3.0
"LDRBA"	Diesel	1,350	8.6	1,800	5.4
"BDRBA"	Diesel	900	7.8	1,800	4.9
"CDRBA"	Diesel	750	12.2	1,800	7.7

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PIPE LINE INDUSTRY for the oil and gas pipe line industry.

WORLD OIL and THE COMPOSITE CATALOG for the drilling-producing-pipe line industry.

PETROLEUM REFINER and THE REFINERY CATALOG for the refining-natural gasoline-petrochemical industry.

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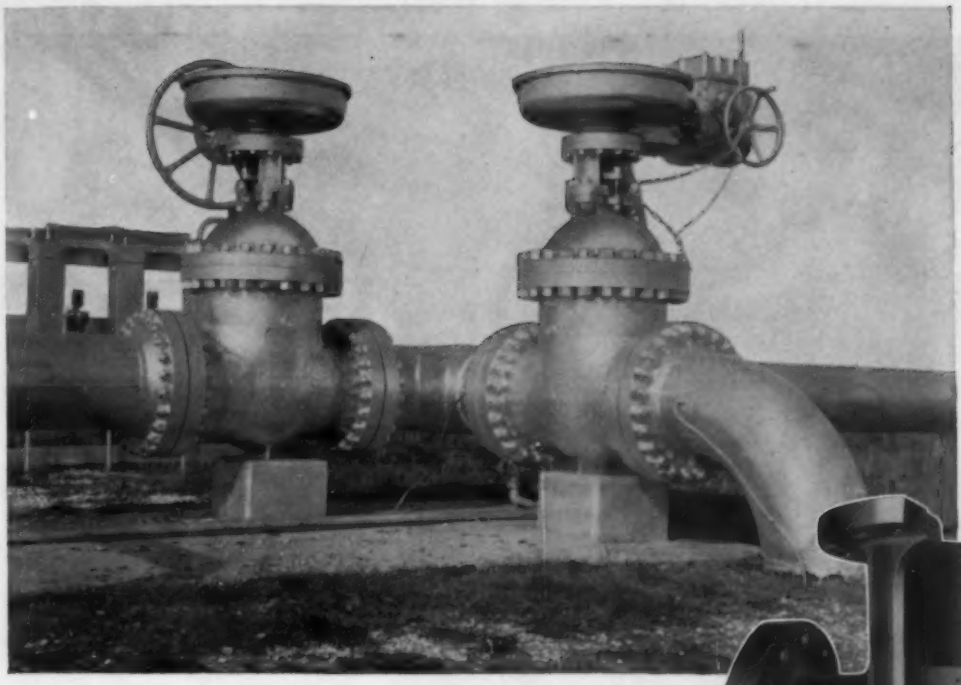
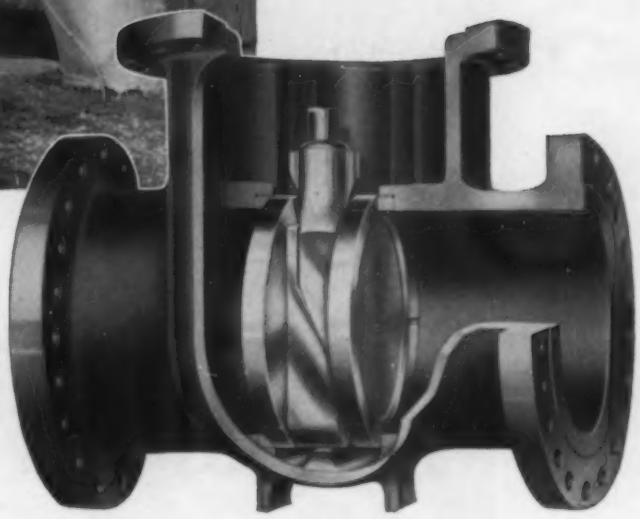


Darling 20" fully revolving double disc, parallel seat cast steel gate valves, with manually and motor-operated bevel gear, installed on a major line.



Darling cast steel pipe line gate valves

Rated tops at keeping out of trouble!

IT won't cost you a cent to find out *why* you stand to save plenty with Darling pipe line gate valves on the job. Aside from extra rugged, stress-proved construction throughout, it's Darling's unique fully revolving double disc, parallel seat principle that *really* pays off!

Take a close look at the cutaway view. The rugged, self-adjusting wedges *automatically* seat the fully revolving, no-pocket discs, assuring tight, easy closure. Coupled with uniform wear distribution, these valves do a better job and last longer with less attention, less maintenance.

If it's proof of performance you're after, check with some of Darling's pipe line users. Meanwhile, you are welcome to a descriptive bulletin giving *all* the money-saving facts. Darling gate valves are available in all pressures and various constructions for main line, gathering, manifold, tank farm and all other services.

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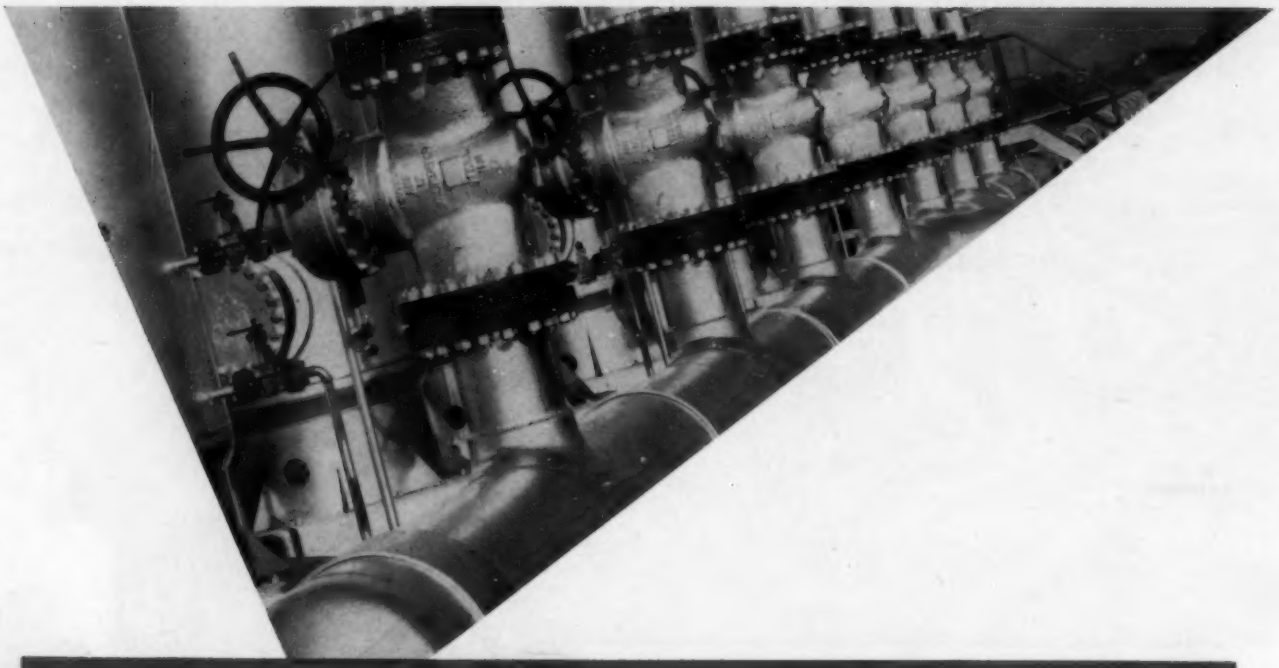

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The plug in a Walworth is always seated in the body; nothing in the line prevents the valve from opening or closing – and a quarter-turn does it.

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Walworth Plug Valves are so completely satisfactory for so many types of work that they have come to be known as "all-purpose" valves.

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	.142"	6.61
	.156"	7.25
	.188"	8.64
	.219"	10.00
	.237"	10.79
6⅝	.134"	9.29
	.156"	10.78
	.188"	12.89
	.219"	14.97
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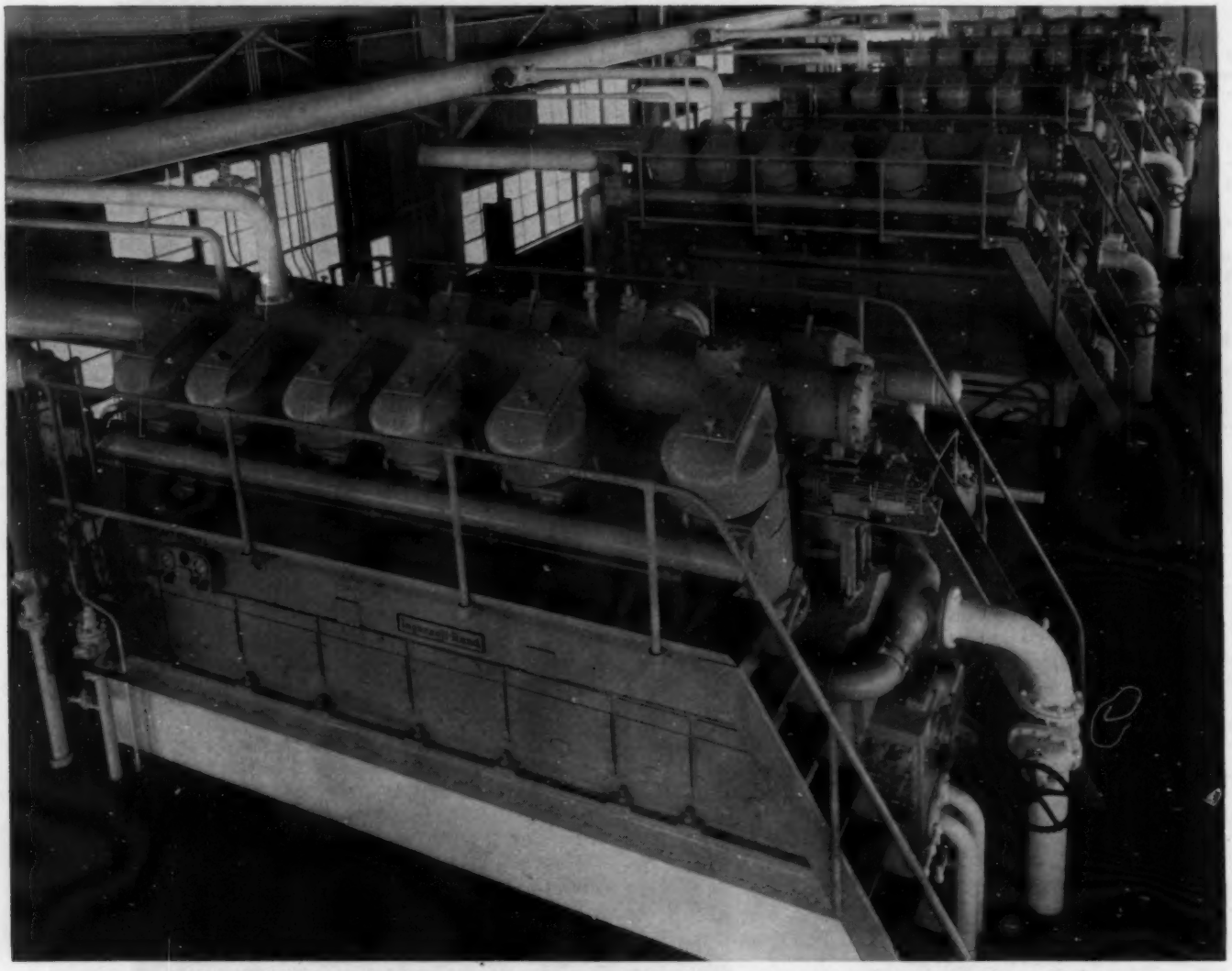
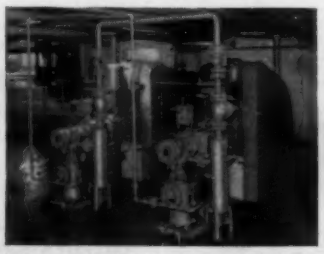


Ingersoll-Rand KVG gas-engine compressors on natural gas storage and transmission service at Tennessee Gas Transmission Company's Coudersport (Pa.) station. Each unit is rated 1320 hp.

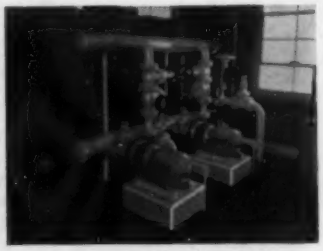
OTHER I-R EQUIPMENT AT COUDERSPORT STATION

PSVG-8 gas engine, rated 544 hp, driving a 380-kw synchronous generator for supplying plant power.



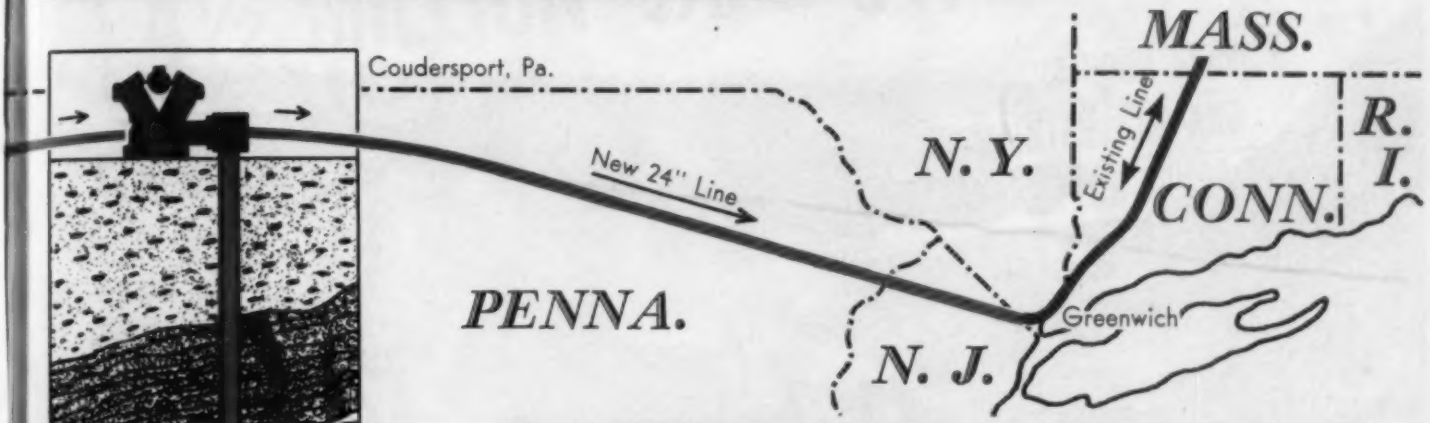
Two electric motor-driven Type ES compressors supplying 250-psi starting air for the KVG compressors.

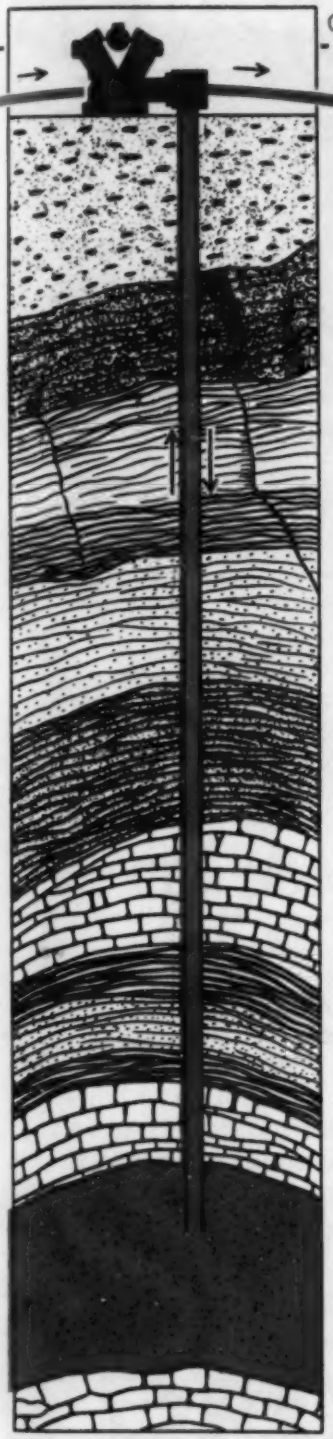
Two Class LFV centrifugal pumps supplying jacket cooling water for the KVG's; each pump rated 2200 gpm, 60-ft. head.



Two Class RVL Motorpumps supplying jacket cooling water for the PSVG gas engine; each pump rated 312 gpm, 59-ft. head.

four-cycle flexibility and transmission station





Cross-section of underground storage field, where vast quantities of natural gas are injected into porous sands capped by thousands of tons of rock and shale.

Ten KVG gas-engine compressors on unusual dual-purpose job serve New York City area

Billions of cubic feet of southwestern gas are now being inhaled by Pennsylvania's once-productive Hebron gas field, to be exhaled through a new 250-mile pipeline when winter weather swells New York City's gas needs. This new system is a part of the growth of Tennessee Gas Transmission Company, and the lungs of the system are ten Ingersoll-Rand KVG gas-engine compressors totalling 13,200 hp at TGT's Coudersport (Pa.) pipeline station.

These compressors inject the gas into the underground storage field, and later boost it through the line to the consumers. Compressors on such a double-duty job must operate over a wide range of speeds and loads — a need well met by the inherent flexibility of I-R four-cycle machines. (For example, these KVG's operate from 300 to 1600 psig intake, and 900 to 2500 psig discharge.)

These V-angle, 4-cycle units actually deliver smooth power without skipping or stalling, all the way from full load to no load, from half speed to full speed, and with generous reserve for temporary overloads. All this, plus the proven dependability and trouble-free performance of I-R compressor cylinders and valves.

For sustained top performance under the most demanding conditions, it pays to specify Ingersoll-Rand 4-cycle gas-engine compressors. Ask your I-R representative to show you how these heavy-duty units can make long-range savings in your compression costs.

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6-258

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4-CYCLE

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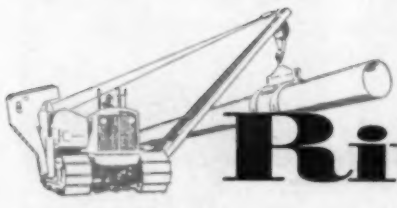

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REPLACEMENTS

*An actual pipeline operating record where Brodie Model B-72D Meter was inspected after metering 189,000,000 gallons of gasoline and heating oil.

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Field operating records prove Brodie BiRotor Meters' long service performance with low maintenance and high sustained accuracy. For crude or finished product lines, gathering systems and product blending, why not avail yourself of Brodie's specialized metering experience?

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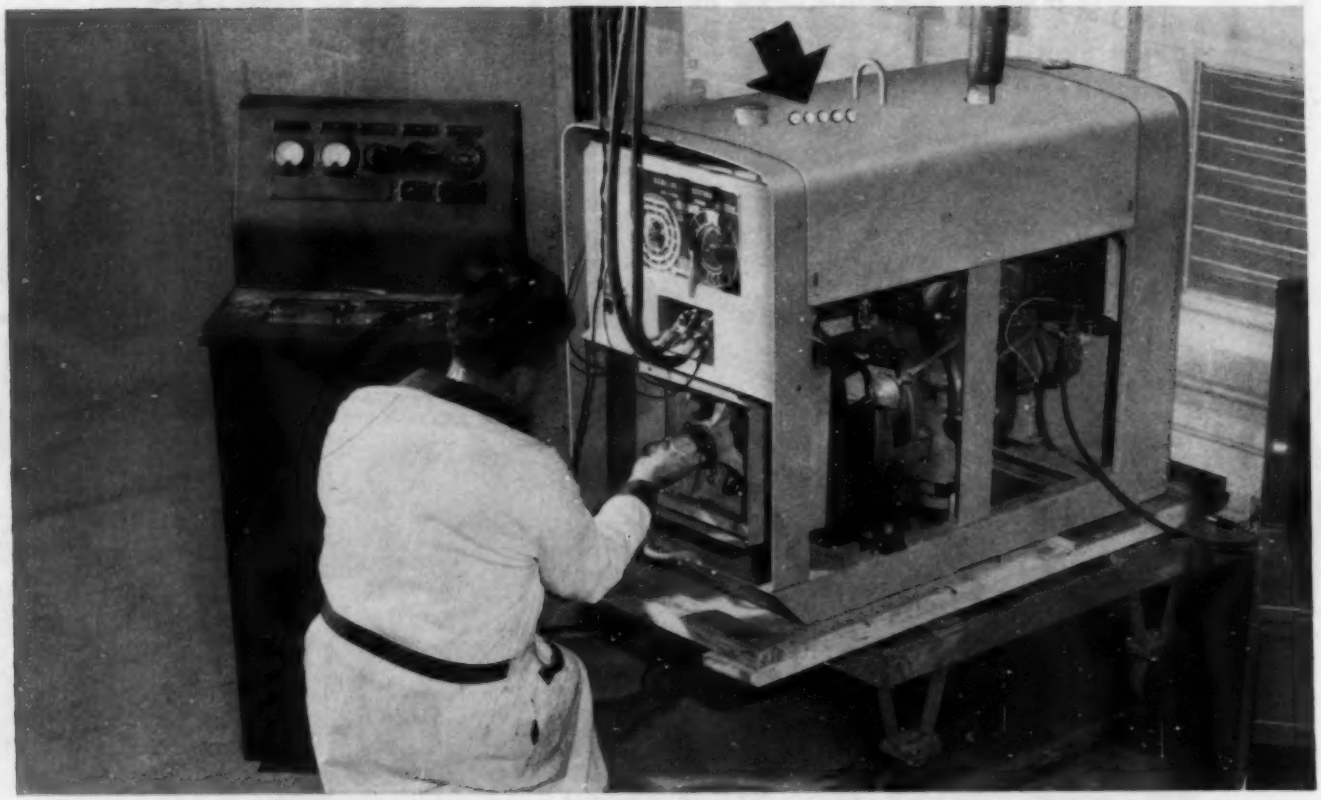
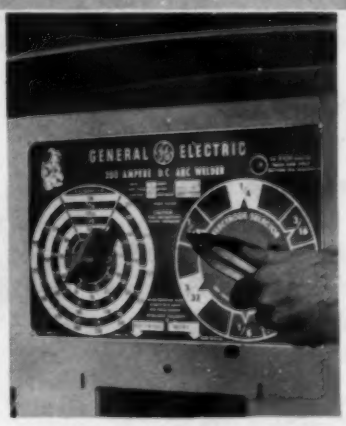
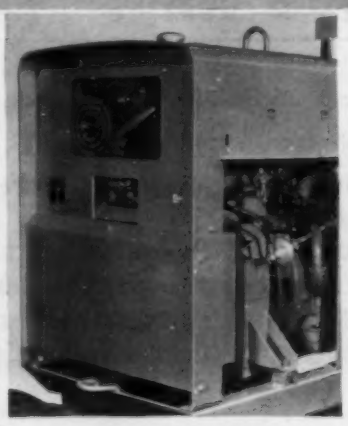


5 NICKELS STAND ON END while the new G-E 200-amp welder runs at full load. This unusually steady operation demonstrates the advanced engineering thought which makes the G-E engine-drive welder your best performance buy.

PROVE IT TO YOURSELF—Make this actual feature-by-feature comparison of the new 200-amp G-E engine-drive welder with two other welders of the same rating. You will see that only the new G-E welder has so many advanced design features for better welding performance at lower cost.



ELECTRODE SELECTOR, CURRENT DIAL—Dual controls simplify current control, give you easier, more accurate adjustment.



NON-PROJECTING GENERATOR—No vital parts are exposed. Full-length base encloses generator for rugged in-the-field welding.

PUSHER ENGINE FAN—Air is blown out of radiator, helping to prevent vapor lock.

GENERAL ELECTRIC	✓	✓	✓
MANUFACTURER A			✓
MANUFACTURER B			

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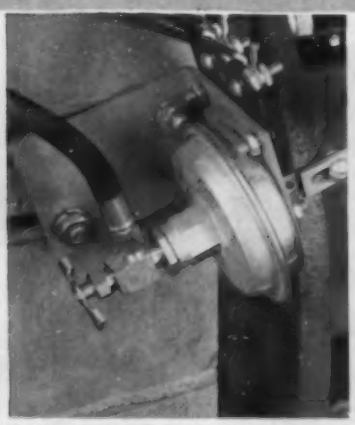

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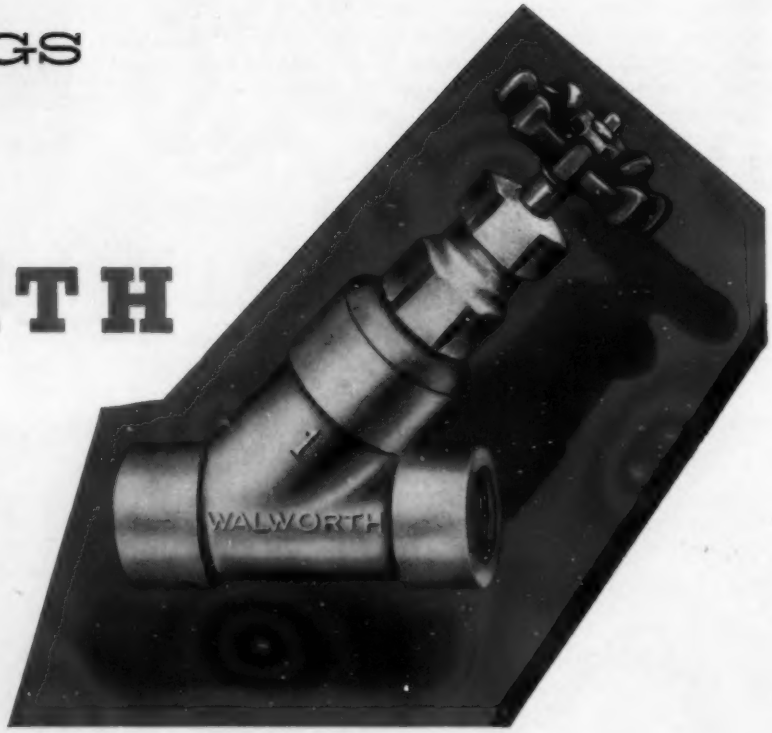

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NOV.	
1– 3	National Association of Corrosion Engineers, Northeast Regional Meeting, Hotel Niagara Falls, Niagara Falls.
1– 5	World Symposium on Applied Solar Energy, Sponsored by Stanford Research Institute, Association for Applied Solar Energy and University of Arizona, Westward Ho, Phoenix, Ariz.
2– 4	Society of Automotive Engineers, Diesel Engine Meeting, Chase Hotel, St. Louis.
3– 4	Annual Instrumentation Conference, School of Engineering, Louisiana Polytechnic Institute, Ruston, La.
9–10	Society of Automotive Engineers, Fuels and Lubricants Meeting, Bellevue-Stratford Hotel, Philadelphia.
13–18	American Society of Mechanical Engineers, 75th Anniversary Meeting, Hilton and Blackstone Hotels, Chicago.
14–17	American Petroleum Institute, Annual Meeting, Mark Hopkins, Fairmont, St. Francis and Palace Hotels, San Francisco.
14–17	Automation Exposition and Symposium on Electronic Computers, Navy Pier, Chicago.
14–18	Chicago Exposition of Power and Mechanical Engineering, Sponsored by the American Society of Mechanical Engineers, Chicago Coliseum, Chicago.
16–18	Southeastern Gas Association, Roanoke Hotel, Roanoke, Va.
27–29	New Mexico Oil and Gas Association, Albuquerque, N. Mex.
DEC.	
1– 3	Interstate Oil Compact Commission, Annual Winter Meeting, LaFonda Hotel, Santa Fe, N.M.
2	Natural Gasoline Association of America, Panhandle-Plains Meeting, Herring Hotel, Amarillo, Texas.
8– 9	American Petroleum Institute, OIIC Meeting, Waldorf-Astoria Hotel, New York.
1956 JAN.	
9–13	Society of Automotive Engineers, Sheraton-Cadillac and Statler Hotels, Detroit.
16–18	Pipe Line Contractors Association, 8th Annual Convention, Boca Raton Hotel and Club, Boca Raton, Fla.
30–Feb. 3	American Institute of Electrical Engineers, Hotel Statler, New York.
FEB.	
15–17	National Association of Corrosion Engineers, Tulsa Section, Corrosion Short Course, Mayo Hotel, Tulsa.
19–23	American Institute of Mining and Metallurgical Engineers, Hotel Statler, New York.
MAR.	
12–16	National Association of Corrosion Engineers, Hotel Statler, New York.
19–21	Mid-West Gas Association, Hotel Fontenelle, Omaha, Nebr.

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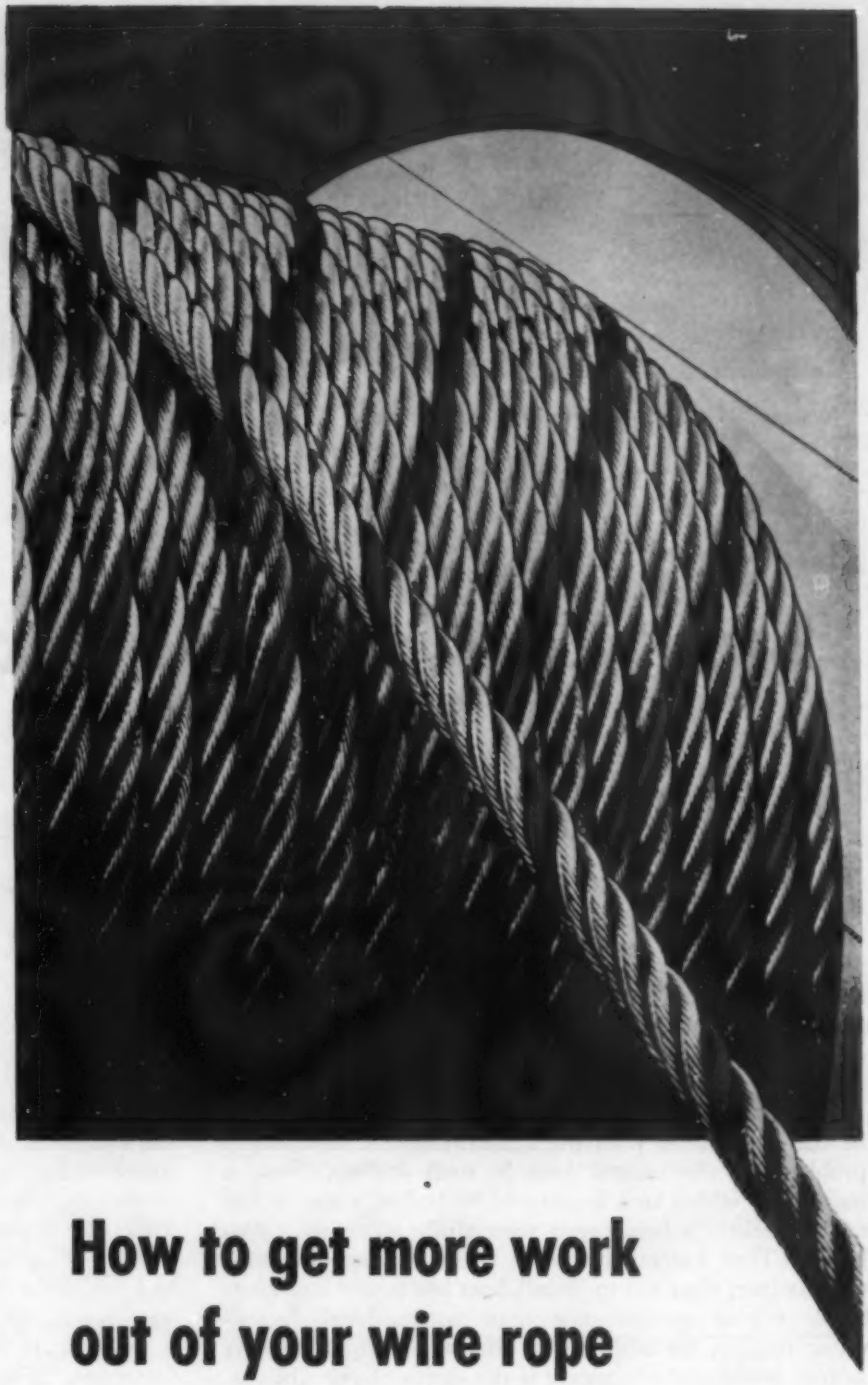

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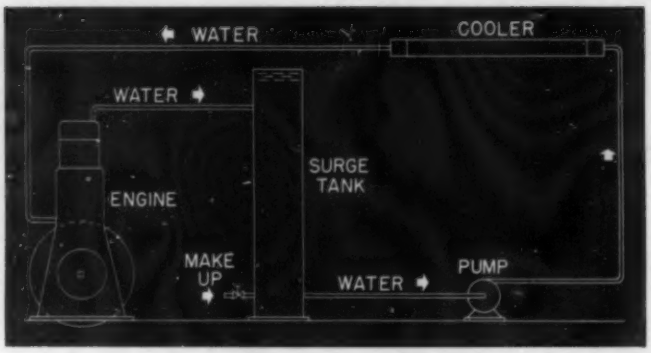

FIGURE 1—Conventional cooling system.

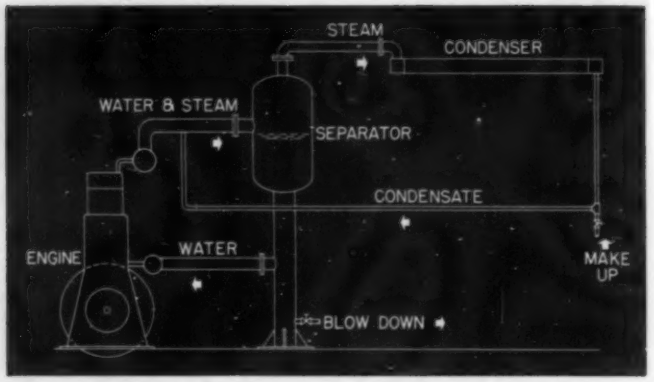

FIGURE 2—Ebullition cooling system.

Ebullition Cooling Is Paying Off

By letting water boil in the engine jackets, cooling equipment is less costly, the engine operates at a more even temperature. It has paid off for Stanolind.

By G. O. BATES, J. E. ENGLISH and G. M. FRANKLIN
Stanolind Oil and Gas Company
Tulsa

SINCE MAN invented the internal combustion engine, he has been faced with the economical and mechanical problems of the unused heat in such engines. Now, a method by which heat is removed by boiling water in the engine jackets is being used successfully on many installations. That system, known as latent cooling or ebullition cooling, costs less to install, uses less power and gives better engine performance than conventional jacket-water cooling. In addition, it effects substantial savings in fuel, water and equipment if the steam can be utilized. For these reasons everyone who designs or uses internal combustion engines should be interested in further use and development of ebullition cooling.

DEVELOPMENT OF EBULLITION COOLING

Ebullition cooling systems were first used on single cylinder engines fitted with open tanks filled with water in which the power cylinders were immersed. Cooling occurred as water boiled from the hot surfaces within the jacketing vessels.

As far as is known, there was no directed attempt to elevate the temperature of the cooling water to the range of 212° F. to 250° F. in jacket systems for vertical multicylinder industrial engines until the late 1930's. About that time, a high temperature cooling system was introduced which claimed to reduce cylinder wear, to permit use of sulfur bearing fuel gas and to increase thermal efficiency through recovery of waste heat. That system differed from an ebuillition system in that a pump was provided to force circulation through the jackets in order to suppress free boiling within the engine. From 1939 to 1952, this system won a gradually increasing acceptance, usually being favorably considered only when the ability to burn sulfur bearing fuel or the recovery of waste heat was significantly advantageous.

In 1952, O. B. Freeman of Tidewater Associated Oil Company, Ventura, Calif., experimented on vertical multicylinder gas engines with high temperature cooling without the jacket-water pumps. In his experiments, boiling was permitted within the jackets to promote natural circulation through the engine. Apparently, the additional economy permitted by the omission of the water-circulating pump created general interest in the ebullition type high-temperature cooling among operators of oil field gas engines. As a result, over 40,000 engine horsepower in compressor service alone has been equipped with ebullition cooling since 1953.

COMPARISON OF EBULLITION AND CONVENTIONAL COOLING SYSTEMS

Figure 1 shows a conventional forced-circulation water system with the engine, the surge tank, the pump and the cooler.

Figure 2 shows a simplified ebullition cooling system

with the engine, the separator and the steam condenser. A mixture of water and steam from the engine enters the separator. The steam flows to an elevated condenser from which condensate is returned by gravity to the fluid stream entering the separator. This mixing ahead of the separator provides uniform temperatures in case the condensate has been subcooled. There are no pumps because all circulation is maintained by the difference in densities between the water in the separator and the mixture of water and steam in the jackets.

The ebullition system requires less heat transfer surface and a smaller cooling-air fan than a comparable forced-circulation water system because of the greater temperature differences and higher heat transfer rates that result when condensing steam.

Power requirements are less because of the smaller fan and driver and the elimination of the engine-jacket water pump. Obviously, operating and maintenance costs are lower for the same reasons.

In addition, engine maintenance costs are reported by several operators to be less. Uniform heat transfer at a high rate is achieved by the turbulent boiling action and there is little or no gradient in the temperature of the coolant. Therefore, the cylinder walls have more uniform temperatures and less distortion or taper than with conventional cooling. Those conditions result in less wear of the cylinders and pistons, thereby reducing piston blowby and oil sludging.

Figure 3 compares the initial costs of cooling equipment for both the ebullition system and the conventional system for slow-speed engines. Cost in dollars per engine horsepower based on June 1955 prices is plotted against engine horsepower. The costs for ebullition systems include the purchase prices for a separator, an air-cooled steam condenser and the necessary instruments and controls to maintain a steam pressure less than 5 psi. The costs for conventional systems include the purchase prices for a jacket-water surge tank, a jacket-water pump, an air-cooled exchanger and the necessary instruments and controls to maintain a maximum water temperature of 170° F.

Figure 4 compares the auxiliary power required by cooling equipment covered by Figure 3 for both the ebullition system and the conventional system for slow-speed engines. Auxiliary horsepower, expressed in per cent of engine horsepower, is plotted against engine horsepower. The power for the ebullition system is that required by the fan. The power for the conventional system includes that required by the fan and the jacket-water pump.

Figure 5 compares the installed costs of slow-speed engine cooling equipment for both the ebullition system and the conventional system. The units and the basis for the indicated values are similar to those of Figure 3. The costs include all labor and material which are required to make the installation ready for operation.

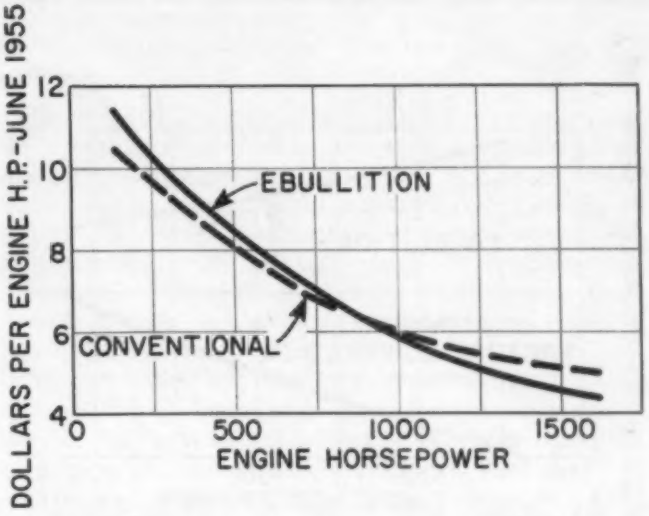

FIGURE 3—Price of cooling equipment for slow speed engines.

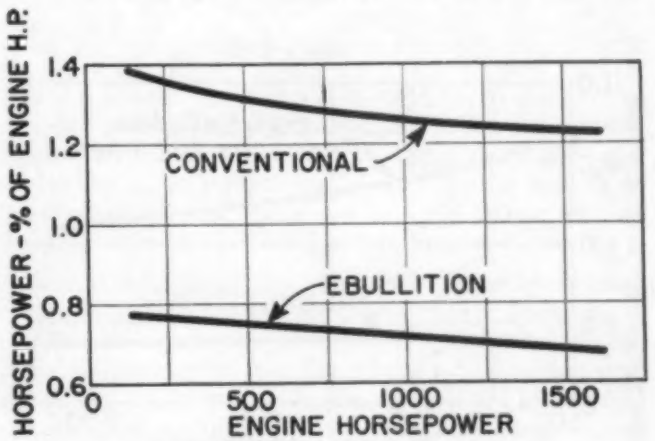

FIGURE 4—Power for cooling slow speed engines.

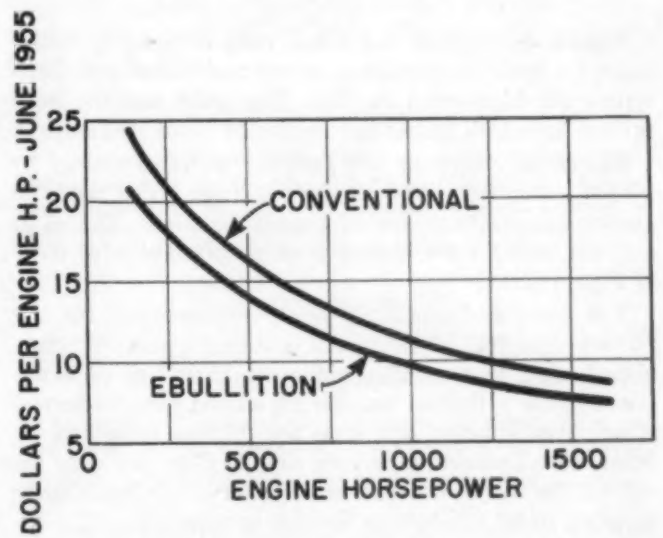

FIGURE 5—Installed costs of cooling equipment for slow speed engines.

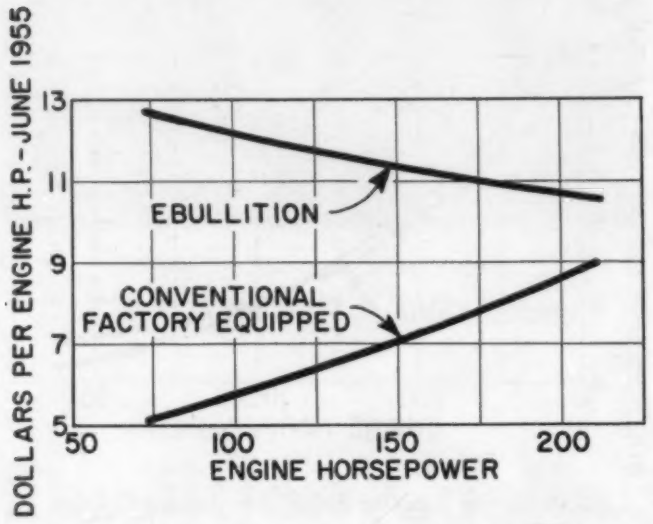

FIGURE 6—Price of cooling equipment for high speed engines.

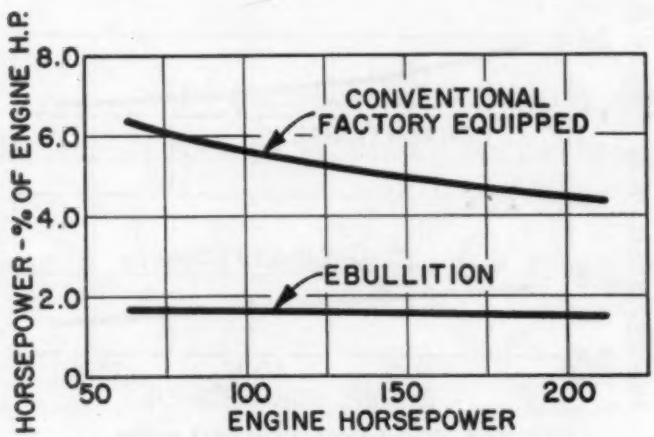

FIGURE 7—Power for cooling high speed engines.

Figure 6 compares the initial costs for cooling equipment for both the ebullition system and the conventional system for high-speed engines. The units and the basis for the indicated values are similar to those of Figure 3.

Figure 7 compares the auxiliary power required by cooling equipment for both the ebullition system and the conventional system for high-speed engines. The units and the basis for the indicated values are similar to those of Figure 4.

The costs and auxiliary power requirements for the factory-equipped conventional systems (radiators) furnished with high-speed engines are based on data obtained from a limited number of engine manufacturers. Power requirements and costs for engines furnished by other manufacturers may vary slightly from the data indicated. However, these values are considered sufficiently accurate to be satisfactory for this comparison.

In all cases, the data apply to complete systems for cooling only jacket-water on single engines. For cases where a single system is used for cooling several engines or jacket cooling is integrated with other services, somewhat different data will apply.

Installed costs for cooling equipment on high-speed engines are not given because such data were not available.

No data are given for high temperature water cooling systems because there are no economic or operational advantages for such systems in comparison with ebullition systems.

At least 15 percent, and in many cases as much as 30 percent, of the heating value of the engine fuel goes into steam which is generated in an ebullition system. Therefore, very appreciable fuel savings can be made if the steam can be utilized, although it is normally condensed in an air-cooled unit. If the steam is used, a condensate return system is usually required, but that cost is offset to some extent by a reduction in size of the steam condenser.

In addition, boiler feedwater and steam generating facilities can be reduced. Usually, a small excess steam condenser is required to handle variations between the rates of steam generation and demand. At present, steam pressures above 25 psig are not feasible in standard engine jackets. Such low pressure steam can be used for space heating, process heating and absorption-refrigeration. If higher pressures could be generated, more general use of the steam could be made, with attendant savings in boiler facilities.

High temperatures associated with the higher steam pressures would probably have some effect upon cooling efficiency. However, potential savings are so great that considerable experimental and development work on high pressure jackets is justifiable.

DESCRIPTION OF STANOLIND'S INSTALLATIONS

Each of four engine-driven compressors at the Midland Farms plant is equipped with an ebullition cooling system similar to that shown in Figure 2. The steam is condensed in the upper section of an elevated air-cooled unit, while water used for cooling the compressor cylinders and the lubricating oil is cooled in the lower section of the unit.

Each unit is equipped with two small forced-draft fans, which blow air vertically across the two coils in series. Those fans and a pump for circulating cooling water through the compressor cylinder jackets are equipped with hydraulic motor drivers.

Each compressor engine drives a hydraulic pump which supplies hydraulic power to the motors. Originally, a manual by-pass around each hydraulic motor provided speed control for varying the flow of air and water. The fans are now equipped with automatically controlled bypasses which are actuated by steam pressure. Controlling the fan speed in this manner prevents fluctuation of the steam pressure with changes in atmospheric temperature.

RESULTS OF OPERATING EXPERIENCE

A single system to serve all engines was considered for Midland Farms but since that was a trial installation, individual systems were used in order to simplify operations and to provide maximum performance data. The individual units are usually more expensive and they necessitate special precautions to prevent freezing when an

engine is not in operation. A combined system minimizes the freezing hazard because some thermal circulation is maintained throughout the system as long as one engine is running. Therefore, future installations will use combined cooling systems where practical.

When an ebullition system with thermo-siphon circulation is to be installed, it is essential that the pressure drop through the equipment and piping be thoroughly investigated. The relative elevation of the separator and engine and of the condenser and separator are controlled by the pressure drops in the system. Restrictions in the piping to and from the engine reduce the amount of water circulated through the engine and restrictions in the steam piping to the condenser raise the operating pressure of the system. An inadequately sized condensate line restricts flow from the condenser, thereby flooding some of the condenser surface. This condition results in higher system pressure and in subcooled condensate.

With some engines alterations of the internal jacket construction or additional piping connections are required to reduce pressure drop or to eliminate vapor pockets. Therefore, the engine manufacturer should always be consulted regarding the use of ebullition cooling.

Experience has indicated that it is advisable both to control the flow of air and to slope the tubes for drainage in any air-cooled equipment in which the fluid is subject to freezing. Under certain conditions where the condensate became subcooled and did not flow with sufficient velocity, some sections of air-cooled steam condensers have frozen while in operation. When a constant-speed driver is used, the amount of air is usually controlled by shutters or variable pitch fans, which may be operated either manually or automatically. In some cases, the flow of air may be controlled by changing the speed of the fan with a variable speed drive. Otherwise, complicated instruments and controls for an ebullition cooling system are not required. The separator is usually provided with a low-level alarm or shutdown device, a gage glass and a pressure relief valve. The condenser is provided with a combination vent and vacuum breaker which removes noncondensables and prevents vacuum in the system when it cools after shutdown.

Some difficulties were experienced in operating the hydraulic drive systems on the Midland Farms units due to faulty hydraulic equipment and foreign material in the hydraulic lines. However, replacement of the faulty equipment and modification of the system have appreciably improved operation. Operators report no particular difference in operation from conventionally cooled engines, except for the freezing problem which was discussed earlier. No detonation difficulty has been reported although the fuel has a rather high Btu content. The oil has not been adversely affected to any detectable degree by ebullition cooling. No extraordinary sludging is indicated in the full flow oil filters.

Engine performance tests demonstrated that the South Fullerton engine could handle 120-125 percent of its altitude horsepower rating after six months' operation. Such performance is obtainable only if the engine is in good mechanical condition and therefore it indicates that no unusual wear has occurred. No inspection has been made of the condition of crankcase, bearings, or power cylinders, but there is no indication of piston blowby or sludging of the oil. There has been no detonation experienced except for a slight pinging when the engine was overloaded. Operators report that the engine cooled by ebullition required less attention and runs smoother than any other compressor engine at the location. There are no particular startup, shutdown, or operating problems.

Proper water treatment is essential for low maintenance and continuous operation in any system which uses water. Normally, treatment for steam systems is more expensive and requires closer attention than treatment for liquid systems. However, treatment of ebullition systems for engine cooling is not difficult because of low makeup requirements with the closed cycle. If possible, steam condensate or rain water should be used in any type of jacket-water cooling system. With such water, satisfactory protection against corrosion can be obtained in ebullition systems with the same high chromate treatment that is suitable for conventional systems. If raw water must be used in an ebullition system, a phosphate treatment suitable for low pressure boilers will protect against formation of scale. With such treatment, a sulfite residual must be maintained in the system at all times to prevent oxygen attack.

CONCLUSION

On the basis that ebullition cooling is economical, efficient, and simple, as indicated by the cost and operating information presented herein, the authors' company expects to make general use of such cooling on future installations of slow speed gas engines, except for unattended units in areas with serious freezing problems.

Several companies already have similar plans and others may be expected to follow the trend to make ebullition the generally accepted method for cooling internal combustion engines. Therefore, manufacturers should be ready to provide engines that are satisfactory for ebullition cooling without alteration of the jackets or installation of complicated piping. Jackets should also be designed for high pressures so that steam generated in them can be used for general service. Then the internal combustion engine will be more efficient than was ever hoped in the past.

ACKNOWLEDGMENT

This is from a paper presented at ASME, New Orleans, September 25-28.

The authors thank the management of Stanolind Oil and Gas Company for permission to publish this article. Appreciation is also expressed to operating personnel who provided information from the plants and to G. C. Hickman who assisted in preparation of the cost data.

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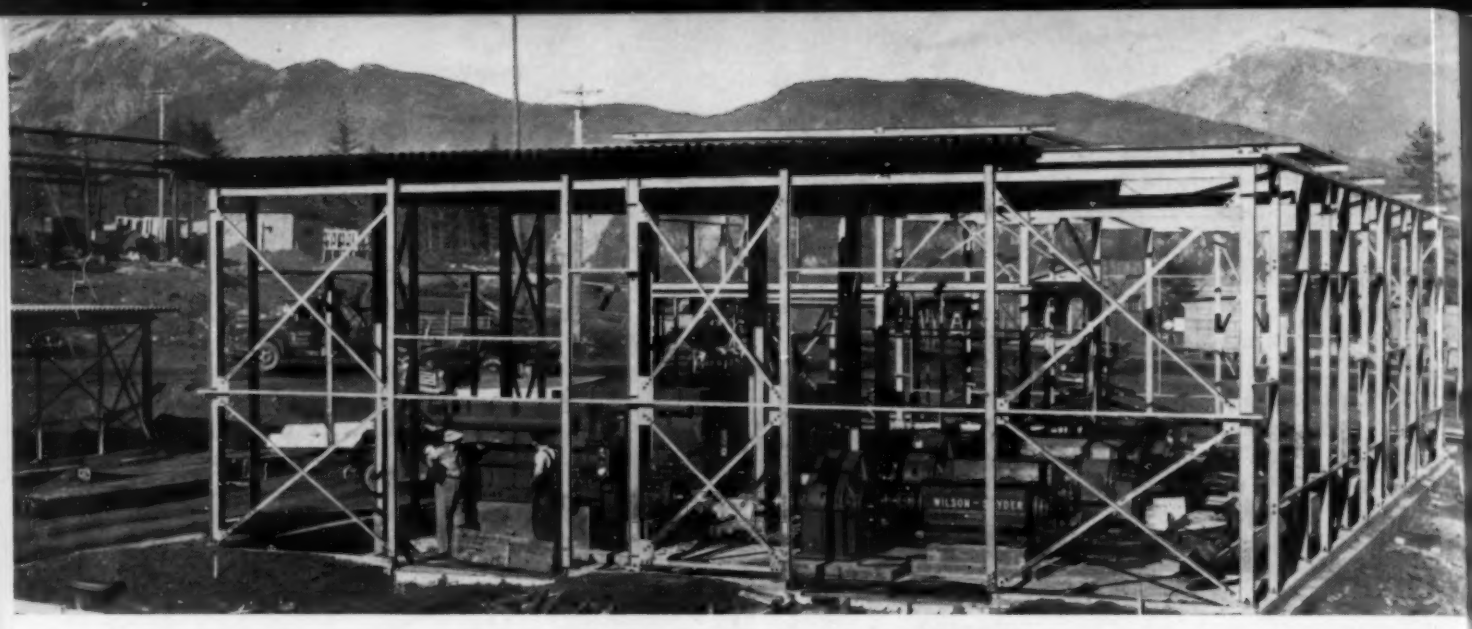


Pump building under construction at Station No. 1 at Haines.

ALASKAN LINE STATIONS ARE DESIGNED FOR WEATHER EXTREMES

How would you go about designing a station to handle fluid temperature variations from 42° F. to 102° F. over a 24-hour period . . . with operating temperature ranging from —80° F. to 100° F. Here is how those special design problems were solved on the Alaskan products line.

By HUGH ROBINSON, Assistant to Project Manager,
Williams Bros.-McLaughlin-Marwell Joint Venture
Anchorage, Alaska

THE ARMY'S $40 million, eight-inch products pipe line—ALCANGO—extending between Haines and Fairbanks, Alaska, is now completed and serving the fuel needs of America's northern military bases. It was designed primarily to transport diesel fuel, jet fuel, motor gasoline and aviation gasoline. It is the largest single project yet undertaken in Alaska.

From the port of Haines in southeastern Alaska the pipe line stretches 626 miles northwest to Fairbanks in the central interior. One third of the steel pipe crosses Canada's British Columbia and Yukon Territory; two-thirds lies within Alaska.

Building the pipe line has been a triumph over time, weather and rugged country, climbing mountain passes, fighting snow, ice, glaciers, permafrost and tundra; spanning the creeks, swamps, rivers and lakes.

Route of the ALCANGO was selected by the U. S. Army, Alaska, and the Corps of Engineers to utilize the sheltered waterways of the Inside Passage up the coast, and the overland highway in the interior. It was constructed under the supervision of the Alaska District, Corps of Engineers, and is being operated by the Quartermaster Corps for the U. S. Army in Alaska. The Canadian government extended full cooperation in the project.

The system includes a tanker wharf, pump station and tank farm constructed on Lutak Inlet near Haines from which the line rises steeply across the Canadian border to a second pump station in British Columbia, 48 miles to the north. This station provides power to push fuel over the crest of the Chilkat Pass on the old Dalton Trail from where it flows northwestward past two emergency pump stations (Nos. 2A and 2B) in the Yukon Territory, back across the Alaskan border into the upper Tanana Valley and on to station No. 3 and its tank farm at Tok Junction, Alaska. From Tok it passes down the Tanana Valley to the take-off facilities at Big Delta, Eielson and Ladd fields.

Fluor Corporation of Los Angeles designed the pipe line in 1952. In October, 1953, the contract for construction was awarded to an international joint-venture sponsored by and including Williams Brothers Company of Tulsa, McLaughlin, Inc., of Great Falls, Mont., and Marwell Construction Company of Vancouver, B. C.

Modern Station Design . . .

Marwell took a subcontract from the joint venture for the part of the project covering construction of the tanker wharf, pump stations and take-offs, and it immediately started work on shop drawings, the placement of purchase orders and the subcontracting of specialties.

In March of 1954, clearing and grading of the Haines terminal site commenced with the spring run off along the coast. This was a difficult time of the year to start such work, but there being no choice, decision was obvious and for the next few months heavy equipment wallowed deep while clearing approximately 150 acres of spruce forest, glacial clay and boulders. This was some of the hardest work of the project.

The Haines terminal comprises a tank farm, a manifold transfer building, mainline pump building, utility building and miscellaneous shop, office and warehouse facilities together with living quarters for station personnel.

The utility building houses four 720-rpm, 285-hp diesel engines driving 150-kw generators which supply all station electricity. For normal operation two generators will supply sufficient current but a third is required to carry peak loads. The fourth is used as a standby.

The steam generating plant of the station consists of three oil fired boilers. Two are sufficient to carry the station load while the third acts as a standby. These boilers are of the self contained package unit type rated at 100 hp and 15-psi pressure.

In order to reduce contamination, the manifold transfer building contains two separate headers; one for diesel and jet fuel and the other for motor gasoline and aviation gasoline. Each header has its own 30-hp motor driven centrifugal transfer pump capable of discharging approximately 2000 gpm at 120 feet discharge pressure. They are designed to help the tankers unload into the storage tanks, to transfer products within the Terminal or to boost the suction pressure of the mainline pumps. In addition to the transfer pumps, there are two Warner Lewis water separators in this building, each rated at 1000 gpm.

The mainline pump building houses three quintuplex plunger pumps rated at 272 gpm at 110 rpm, 1200-psi discharge pressure, each of which is driven by the same type diesel used to power the generators. The engines are coupled to the pump by means of a six to one geared speed reduction unit and engine speeds range from 720 rpm to 420 rpm giving a mini-

Aerial view of tank farm during construction at Station No. 3 at Tok Junction.

Valve starts fuel flowing northward to Fairbanks. Line was in final pressure testing stage.

Modern Station Design . . .

mum throughput of approximately 240 barrels per hour with one unit on the line and a presently undisclosed maximum of considerably more with all units operating at full rack.

In addition, the pump building contains a 1200-gallon prover tank, an elaborate arrangement of meters normally to be used on this line for obtaining batch quantities of products as they are pumped into the pipe line, two filters, a gravitometer, tank gages and an array of controls.

The Tide-Bay Company of Tacoma, Wash., which handled all the mechanical work and most of the electrical work on the pipe line system, and Chicago Bridge & Iron Company, which erected the storage tanks, were the main subcontractors under Marwell Construction Company.

With the passing of the equinoxial storms in 1954, coastal freighters and barges delivered a steady stream of supplies to Haines and a pile driver moved into Lutak Inlet to commence driving piles for the tanker wharf. This completed the major facilities to be constructed at Haines.

As the winter weather moderated on the north side of the mountains, work also started on the two small stations in the Yukon and the larger one at Tok. This was during April and May of 1954, but it was not until the opening of the Haines Cutoff road in June that ground could be broken for station No. 2 which lies in the heavy snow belt of the Alaska Coastal range.

Of these stations, No. 3 at Tok is essentially a duplicate of the Haines terminal. It has the same size tank farm and most of its other facilities are identical except that its mainline pump building also houses two parallel-connected triplex pumps for pumping into the 3-inch Canol line to Fairbanks as well as back to Northway.

Station No. 2 in British Columbia has no tank farm and consequently no manifolding. It is, however, critical to the operation of the line because from its 1300-foot elevation the pipe rises within seven miles to 3750 feet at the crest of the Chilkat Pass. To accomplish this lift, diesels drive three four-stage centrifugal pumps with a discharge pressure of 1450 psi. The high pressure, necessitated that pipe of .312-inch wall thickness be laid up the slope of the pass instead of the usual .277-inch wall thickness used on the rest of the line.

Stations No. 2A and 2B are small booster stations each with two centrifugal pumps not usually in operation. For normal throughput, only Stations No. 1, 2 and 3 will be required to pump, but for increased throughput, Stations No. 2A and 2B will go on the line. Provision has also been made in the design for three future booster stations to assure emergency throughputs to the take-off facilities at the northern bases. These take-offs are relatively small, housing only the necessary block valves, control valves, strainers and flowmeters.

Due to the distances involved in sending shop drawings from Vancouver to Los Angeles for Fluor Corporation's approval before distribution to the field and problems which developed with both the U. S. and Canadian customs, initial delays were encountered which were further complicated by the issuance of over 150 change orders before the project was completed. The frequent changes created major administrative and construction problems, but procedures for handling them were gradually worked out so that by the advent of winter, all five stations were closed in and work at Haines continued indoors until Christmas. In the interior, however, work stopped in mid-November when the temperature dropped, reaching —73° at Tok on Christmas Eve.

Crews reported back to all stations as early as possible in 1955 and made such progress that the first tanker unloaded 50,000 barrels of diesel oil at Haines on May 28, five weeks ahead of schedule. Final construction work was then carried out simultaneously with the testing and adjustment of the system which was turned over to the government for operation in mid-September two weeks before the contract completion date. All work was finished at that time except for a few change orders issued in late August.

After testing the Haines station with water, diesel was pushed up the line to be followed by jet fuel, motor gasoline and aviation gasoline in that order so as to reduce the amount of fluid lost through contamination. Because of the variance in elevation and the extremes of temperature found on the line, the problem of interfacial mixing is more complicated than usual and in order to reduce it,

Terminal wharf at Haines station on the Lutak Inlet.

Pump Station No. 1 inspection during construction, by, left to right, B. E. Barnes, vice president, Williams Bros. Co., Tulsa, Okla.; Col. Carl Y. Farrell, district engineer, Corps of Engineers, U. S. Army, Alaska District; Brig. Gen. Louis H. Foote, division engineer, North Pacific division; Lt. Col. John E. England, resident engineer, Haines-Fairbanks Pipe Line; Brigadier Love, Canadian Army; Warren George, chief engineering division, Corps of Engineers, Alaska District; O. M. McNamara, area engineer, Haines-Fairbanks Pipe Line.

batches are made as large as possible. Where the sequence of products is unfavorable, as for example, when motor gasoline must be followed by diesel fuel, provision has been made for kerosine buffers to be inserted. The table of allowable contamination of one product with another is shown in Table 1 and with judicious use of the tolerances set forth, it is believed that virtually all of the throughput will be usable.

During normal operations, the pipe line is capable of delivering approximately a month's average supply of products in 10 days of pumping so that it will frequently be "dormant" for periods of from 3 to 4 weeks. As the line is surface laid for most of its length, it is extremely sensitive to weather conditions and the problem of thermal expansion becomes critical. This is particularly so in summer when no snow blankets the pipe and fluid temperatures ranging from 42° to 102° F. have been recorded in a single 24-hour period as compared to an expected temperature range from —80° to 100° F.

Assuming a single day sees an average fluid temperature rise of 30° throughout the length of the line and further assuming its full 210,000 barrels to be jet fuel which has a coefficient of expansion of approximately .0005, there will be 3150 barrels resulting from expansion that will have to be displaced. As the expansion of the steel in the pipe will provide for a little less than 50 barrels, the remaining 3100 barrels would disastrously increase the pressure unless bled off. To accomplish this, twin relief valves, set to a pressure which will hold the static head plus approximately 200 psi are located at both Tok and at Fairbanks. As the fuel expands, the excess is automatically bled off through the manifold to tanks containing the same product then lying in the line to the south of the two relief points.

In order to keep the line packed with fluid, the amount bled off is then replaced in the line by the pumps at Haines so that the products do not vaporize in the line during succeeding periods of contraction. Thus, the dormancy of the line during shut down periods is a relative term. The products in the line are, in effect, always subject to movement and it is during these slack periods when laminar rather than turbulent flow occurs in the pipe that a large part of the interfacial mixing can occur.

Another effect of the radical temperature variation is that during the day when the product is expanding and pressures rising, the pumps at Haines fall to a low rate of flow while the output at the Fairbanks end of the line increases. At night, the situation is reversed and Haines can repack the line with ease but less comes out at the northern end.

With the frequent rise and fall of both pressures and rates of flow, it will be difficult to tell from the station gages when a leak occurs in the line. If a pattern could be established to indicate when expansion and contraction take place, it would be of some help, but due to the extent and rapidity of weather changes occurring in the various climatic zones encountered, preparation of such a chart is nearly impossible. As a result, the line will require considerable patrolling.

Under normal circumstances visual inspection would offer few problems, but in the northern wilderness, the shortage of daylight and the intense cold make winter patrolling difficult either on foot or by airplane. During blizzards, it will be impossible. How this problem will be met is a yet unknown. In fact it is one of the many unanswered questions on the Haines to Fairbanks pipe line which is one of the more interesting now in operation. —**The End**

TABLE 1

Contaminant	(Assumed in Tankage) Av. Gas	Mo. Gas	Jet	Diesel
Av. Gas	100%	10%	0%	0%
Mo. Gas	0%	100%	2%	0%
Jet	0%	0%	100%	5%
Diesel	0%	0%	0%	100%
Kerosine	0%	*1%	5%	5%

* Avoid if possible—causes excessive carbon in automotive engines.

Pig is launched at Tok Junction station.

Why Not Operate Compressor Cylinders Without Cooling Water?

By J. L. GALLAGHER and H. W. EVANS, Sinclair Oil & Gas Company, Tulsa

On a number of new installations the author's company has discarded the use of cooling water on compressor cylinders, after two years' operation revealed no measurable loss in gas-handling capacity, no increase in cylinder wear.

ABOUT THREE YEARS ago Sinclair Oil and Gas Company made a study of ways and means of reducing operating and maintenance expense. Having operated compressor cylinders without cooling water during repair periods, it was decided to run tests to determine the effects of this operation. Jacket water was cut off and drained on one cylinder each of first, second and third stages at one plant. Before operating without water, all the parts were inspected and measured for wear. The cylinders were then operated for 30 days and again inspected and measured. No measurable wear was found. The test was continued for an additional 60 days and again on careful inspection no measurable wear was found. Tests were then started at the various other plants and the results were the same for every test. After approximately one year of testing, the plan was adopted at other plants, and the cooling water was shut off from all compressor cylinders.

This experience prompted a study of the theory of compressor cooling.

Compressor Theory. The removal of the heat of compression from a compressor cylinder is an important factor in compressor efficiency. When all the heat of compression is removed we have *isothermal* compression. If none of the heat of compression is removed, we have *adiabatic* compression.

The design of practical compressor cylinders is such that even though water is circulated in the jackets only a nominal amount of heat can be removed and the actual cylinder performance is not far from adiabatic compression. Since in actual practice some, but not all of the heat is removed, this performance would fall in the classification of *polytropic* compression.

Power Requirement. For the purpose of comparing the horsepower requirements of adiabatic and polytropic compression, assume that by circulating cooling water, temperature of the discharge gas is reduced by 20° F. The assumed temperature reduction is intended to be more than will likely occur in practice. This assumption is made high to be sure that the horsepower difference calculated will be as great or greater than any actual instance.

Air is chosen as the gas to be studied because compressed-air data are universally accepted and the horsepower calculated will be a maximum for a given set of conditions. Compare the theoretic adiabatic and polytropic horsepower required to compress 1 million cubic feet of air through four compression ratios. The adiabatic compression ($n = 1.4$) requires 75.2 horsepower and the polytropic compression ($n = 1.365$) requires 74.2 horsepower. This means that the gross benefit of circulating jacket water could not be more than 1 horsepower per million cubic feet of air compressed.

On the other hand, some horsepower must be used to circulate jacket water. If a 500 Btu per horsepower heat rejection from the cylinder is assumed, as recommended by a prominent compressor manufacturer and a 5-degree temperature rise in the cooling water, then more than 0.25 horsepower will be required for pumping the compressor jacket water.

In connection with the comparison of horsepower required, it should be remembered that operators who use closed system cooling generally use the same pumps for circulating water for cooling both the compressor and the engine. This means that high-temperature water will be pumped to the compressor cylinders. This water will heat the incoming gas and so increase the horsepower required to compress a given weight of gas. Thus, it is seen that the horsepower required to circulate jacket water and the additional horsepower required due to heating incoming gas have reduced the very small 1-horsepower gain from the use of jacket water until it can be safely said that the horsepower requirements will be decreased less than 1 percent by circulating jacket water.

Capacity. The maximum gas-handling capacity of a specific cylinder will be increased approximately 0.25 percent by not circulating jacket water. We may safely expect this increase in gas-handling capacity since at the higher temperature the clearance volume will contain less weight of gas at the end of the stroke. The actual amount of increase will depend on the amount of clearance volume and the absolute temperature of the gas remaining at the end of the stroke.

Heat-Transfer Theory. The data in Table 1 are not as extensive as might be desired, however, they do suggest some very interesting studies. It will be noticed that in test No. 1 the temperature of the compressor discharge is actually higher when circulating jacket water than it is when no water is circulated.

A detailed study of heat transfer through the cylinder walls will help explain this phenomenon. This reversal of expected temperatures occurs only where jacket water temperature is relatively high. Figure 1 is a schematic picture of temperature differences through a hypothetical cylin-

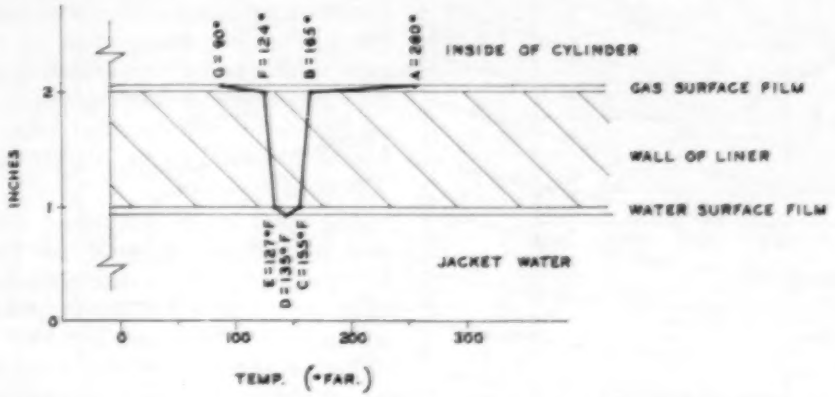


FIGURE 1—Schematic of temperature differences through a hypothetical cylinder wall at the beginning and end of the stroke.

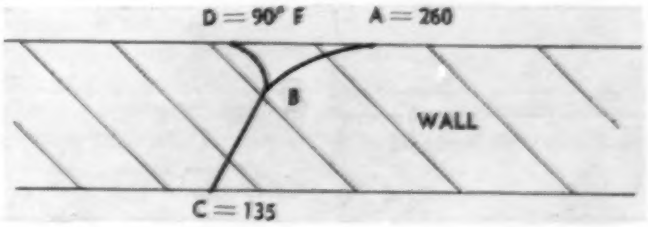


FIGURE 2—Schematic of temperature fluctuation as expected in compressor cylinder wall. This fluctuation penetrates about 1° F. at approximately ⅜-inch.

der wall at the beginning and at the end of the stroke. Points *A*, *B*, *C*, and *D* represent temperature as heat travels from the gas in the cylinder to the jacket water at the end of the stroke. Points *D*, *E*, *F*, and *G* represent temperatures as heat travels from the jacket water to the gas at the beginning of the stroke. The temperatures shown on Figure 1 as the heat flows from the gas to the jacket water are calculated for a flow of 15,300 Btu per hour, or a 20-degree reduction in discharge temperature of 1 Mmcf of air. The heat flow from jacket water to gas was calculated on the basis of temperatures of water and gas shown, and the surface temperatures were calculated from this rate of flow.

It can be seen from Figure 1 that the jacket water would not have to go much higher before the direction of the heat flow is reversed and more heat would travel from the jacket water to the gas at the beginning of the stroke than is returned from the gas to the jacket water at the end of the stroke. Our calculations indicate that with 150° F. cooling water to the hypothetical cylinder, more heat will be transferred from the water to the gas during the suction stroke than from the gas to the water during the compression and discharge portions of the stroke. The tabulated data shows that this actually has accurred. It is also true that as the n-value decreases the temperature at which the reversal of heat flow occurs, will be lower. This situation requires some small additional horsepower to compress the gas.

Figure 1 is treated as if the conditions at the beginning and the end of the stroke existed separately and were of the nature of steady flow to better emphasize the heat flow in each direction. Actually the outside wall of the cylinder liner remains at some constant temperature while the inside temperature of the liner will fluctuate with the temperature of the gas being compressed.

Dr. V. L. Maleeve states that in the internal-combustion-engine cylinder wall the temperature fluctuation does not penetrate deeply. The range of fluctuation is only 1° F. at approximately ⅜ inch from the inside surface of the cylinder. Figure 2 is a schematic picture of this type temperature fluctuation as it is expected to occur in the compressor cylinder wall. This conception of heat transfer helps to strengthen our belief that the conventional compressor cylinder is a very poor heat exchanger.

Quantity of Heat Transferred. The study of the quantity of heat transferred is begun by referring to Figure 3, which is a schematic drawing showing the relationship of stroke to temperatures inside the head end of a compressor cylinder during one complete revolution of the crankshaft. The frame end diagram is omitted to simplify the drawing.

To prepare the data for Figure 3, the performance of a 15.1-inch by 14-inch compressor cylinder operating at 300 rpm with 10 percent of clearance and a compression ratio of 4 is used. This hypothetical cylinder is used because it will compress 1 Mmcf of air from 14.7 psia to 58.8 psia. The calculated quantity of heat transferred through the wall of this cylinder to 90° F. cooling water will be compared with the amount of heat considered to be removed by the cooling water in an earlier example. Referring to Figure 3, air is compressed along line *AB*. This compression increases the air temperatures from 90° to 355° F. To accomplish this compression the piston must move through 9.7 inches of its 14-inch forward stroke. This 9.7-inch of piston travel requires 31 percent of the time for one complete revolution of the crank, and during this time 0.192 Btu is transferred to the cooling water.

The 335° F. air is then discharged along line *BC*. The piston travel is 4.3-inches and requires 19 percent of the time for one revolution. During the discharge portion of the stroke 0.083 Btu is transferred to the jacket water.

Air remaining in the clearance volume is next expanded from *C* to *D* and the temperature is reduced from 335° to 90° F. Expansion occurs through 2.4-inches of piston travel and requires 15 percent of the time of one revolution. During expansion 0.022 Btu is transferred to the jacket water.

Intake occurs from *D* to *A* through 11.6-inches of piston travel, which requires 35 percent of the time required for one complete revolution of the crank. Since the jacket water and the gas are the same temperature in this example, no heat is transferred during the suction stroke. Thus for one complete revolution it is calcu-

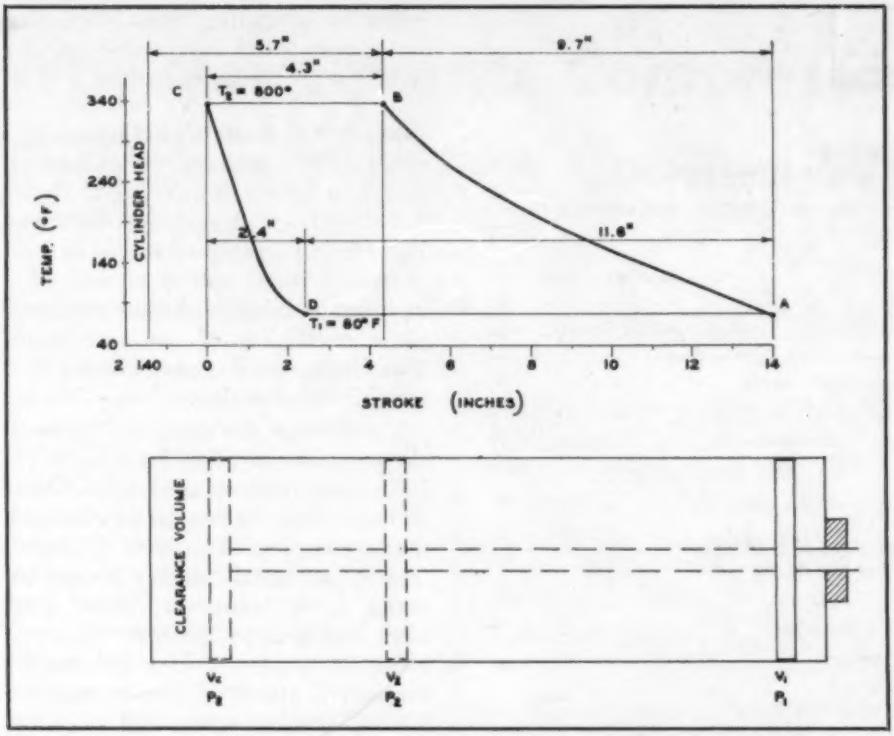


FIGURE 3—Schematic showing relation of stroke to temperatures inside the head end of a compressor cylinder.

lated that 0.279 Btu is transferred through the cylinder walls to the jacket water, from the head end, which is a total of 10,000 Btu per hour. This 10,000 Btu per hour is a great deal less than the conventional figure of 57,500 Btu per hour recommended by engine manufacturers and is considerably less than 15,400 Btu per hour which must be removed by the jacket water if the compressor discharge temperature is to be reduced 20° F. The point is that we are spending time and money installing cooling equipment that is not necessary for efficient compressor operation.

Practical Application. No complicated procedure is required to prepare a plant for operating without cooling water in the compressor jackets. The cooling water is simply shut off, the piping taken out, and the pipe connections covered with screen wire. Filling of the water jackets with oil has been tried, but no definite advantage has been noted. This troublesome procedure has been discontinued. It requires unnecessary time and expense for installation and maintenance. It seems reasonable to expect that the temperature difference between the cylinder liner and piston will be smaller when no cooling water is present.

Experience has been that any compressor cylinder operating satisfactorily with jacket water will do an equally good job without jacket water. Compressor cylinders have been operated without cooling water to as high as 6.5 compression ratios without encountering trouble. It is not possible to say what is the practical upper limit of compression ratio. It should be pointed out that discharge temperature as high as 550° F. has been considered.

This temperature occurred in a station where gas was to be compressed from 26 inches Hg vacuum to 50 psig through three stages without intercooling and compressor jacket water cooling. The difficulty anticipated was in the case where a field line became parted and the gas to the compressor suction changed to air. This high percentage of air in the compressor increased the value *n* and as a result of the increase in *n-value,* the discharge temperature of the gas was increased until it was alarmingly near the combustion temperature of the lube oil and heavy components in the gas. To avoid this high temperature, an intercooler was installed between second and third stages, reducing the danger of explosion.

The operation of compressor cylinders without jacket water has been found to be very helpful, especially in those cases where the engine jackets are cooled by ebullition. The 212° F. or higher water being circulated for the engine jacket is out of the question as a coolant for compressor cylinders. The conventional practice is to install an extra cooling coil to supply colder water for the compressor cylinders. The simplification of the cooling system by omitting the extra cooling coil pump and piping is especially attractive in these cases.

Conclusion. Two years of experience operating plants without the use of jacket water in the cylinders has prompted the belief that there is no measurable loss in gashandling capacity and no increase in cylinder wear.

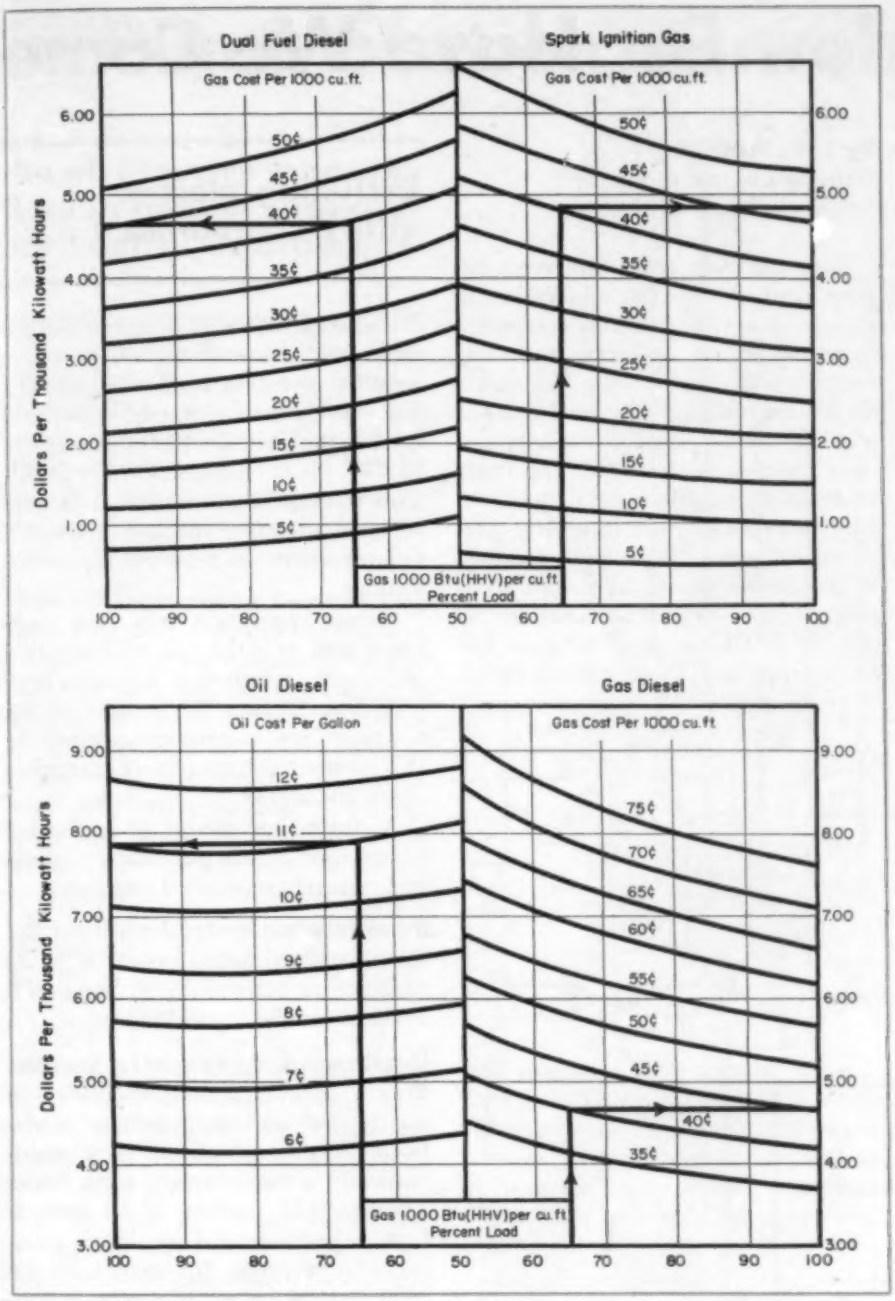
The use of cooling water on gas compressor cylinders on all new installations have been discontinued by the company, thereby saving installation cost of pumps, headers, and compressor cylinder water piping. Also water usage has been reduced, as have treating costs and operating and maintenance expense.

ACKNOWLEDGMENT

This article abstracted from a paper presented at the ASME meeting, New Orleans, Sept. 25-28, 1955, and entitled "The Operation of Compressor Cylinders Without Cooling Water."

TABLE 1

Cylinder Size	Stage	Jacket Water Temp. °F.		SUCTION		DISCHARGE		T	R	N
		In	Out	Psig. or " Hg.	Temp. °F.	" Hg. or Psig.	Temp. °F.			
TEST NUMBER 1										
18 x 20	1st	135	140	11.2"	78	36	266	188	5.61	1.21
18 x 20	1st	None	None	11.2	78	36	264	186	5.61	1.207
8½ x 20	2nd	135	140	31	110	275	298	188	6.36	1.184
8½ x 20	2nd	None	None	31	100	270	283	183	6.25	1.184
TEST NUMBER 2										
33 x 20	1st	85	94	19"	60	5"	168	108	2.33	1.292
33 x 20	1st	None	None	18"	78	3	189	111	2.3	1.288
19 x 20	2nd	85	94	5"	147	45	282	135	5.0	1.142
19 x 20	2nd	None	None	3"	164	49	341	177	4.92	1.184
10 x 20	3rd	85	100	42	97	260	248	151	4.87	1.178
10 x 20	3rd	None	None	44	99	252	267	168	4.56	1.209



FUEL COST CHARTS FOR ENGINE SELECTIONS

By VOLNEY M. HOLMES
Engine Division, Worthington Corp.

ENGINEERS concerned with selecting the most economical type of engine for a given application will find these fuel-cost charts helpful. They compare the relative costs among oil diesel, dual fuel diesel, gas diesel and spark ignition engines. In all cases, lubricating oil cost can be calculated by estimating lubricating oil consumption at 4000 rated horsepower hours per gallon.

Fuel costs for dual fuel diesel and gas diesel include 19,350 Btu (HHV) per pound of *pilot oil* at *ten cents* per gallon. For each cent that pilot oil varies from ten cents per gallon, add or deduct the following amounts to or from the cost shown per thousand kilowatt hours for dual fuel and gas diesels: (a) full load, 2.6 cents; (b) ¾ load, 3.4 cents; (c) ½ load, 5.0 cents.

Example: If diesel fuel oil is available at a price of 11 cents per gallon and natural gas at a price of 40 cents per thousand cubic feet, what is the best engine selection? The average load is assumed to be 65 percent of full load.

Solution: First, refer to the charts titled, "Dual Fuel Diesel" and "Gas Diesel." Follow the arrows and the cost of fuel oil is found to be $4.70, based on pilot oil at 10 cents per gallon. For 11 cent pilot oil, the total correction will be plus 4 cents. Therefore, the total cost of gas and pilot oil per thousand kilowatt hours will be

$$\$4.70 + .04 = \$4.74.$$

The "Spark Ignition Gas" chart shows that fuel for this engine at 65 percent load factor is $4.80.

Similarly, referring to the "Oil Diesel" chart, oil for this type of engine costs $7.85. In this instance, the dual fuel diesel, generating power at a cost of 4.74 mils per kilowatt-hour, is the best selection. Not only is the fuel cost less, but in case of gas failure, it can be changed over instantly to operation on 100 percent oil. When equipped with automatic changeover devices, the engine will automatically go from gas to oil under load.

If oil costs 8 cents per gallon and gas is 20 cents per thousand cubic feet, comparative fuel costs per thousand kilowatt hours are as follows:

Dual Fuel $\$2.55 - (4 \times .02) = \$2.47$
Spark Ignition $= \$2.40$
Oil Diesel $= \$5.70$

In this instance, the spark ignition engines produce the lowest fuel cost by a slight margin compared to dual fuel.

If gas at this price of 20 cents per thousand represents a dumpload rate, then consideration should be given to either a dual fuel or a tri-power engine. In this case, the final decision will depend upon other factors that may be evaluated in addition to the cost of fuel.

It will pay to check local fuel costs. If you are not now using the most economical fuel in your engine, it may be converted to a lower priced fuel for additional savings.—**The End**

How Far Have We Come

About the Author

E. B. TURNER returned to school after serving in the U. S. Navy during World War II and graduated from Texas A&M College in 1949. He taught in the Electrical Engineering department of the college, then went into construction work with Ebasco Services, Inc., before joining General Electric Company in 1951. At present, he is devoting most of his time to the pipe line industry as application engineer.

By E. B. TURNER,
General Electric Company,
Schenectady, N. Y.

THE OIL PIPE LINE INDUSTRY has gone further with the application of remote supervisory control equipment than any other industry, excluding electric utility operations. To obtain an accurate picture of what has taken place in the oil pipe line industry and also, perhaps, to determine the trend of thinking in this respect, questionnaires were submitted to a large percentage of the oil pipe line operators. What follows should be a very accurate picture since it accounts for 93 percent of all the trunk oil pipe line mileage operated in the country today.

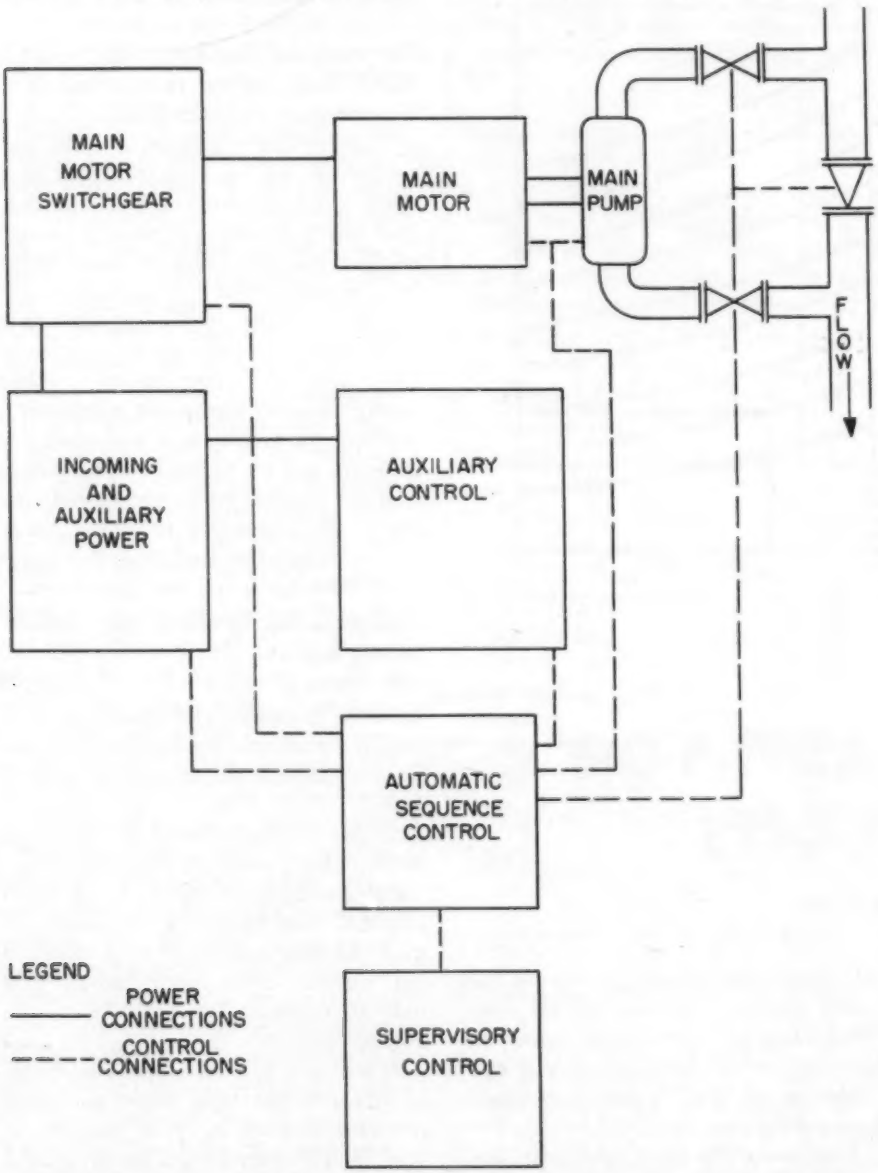


FIGURE 1—Functional block diagram of remotely supervised pipe line pumping station.

Excluding electric utility companies . . .

Although this survey represents this large percentage of the oil pipe line industry, the actual miles of oil pipe line which are remotely supervised total approximately 4000 miles out of 83,870 (ICC statement No. 5428). This is something less than 5 percent of total trunkline mileage. However, this represents 50 remotely supervised stations.

Remote operation is a new technique and, as is the case with any new technique, acceptance has not been complete. In fact, 70 percent of the oil pipe line companies covered by this survey have no remote control in trunk line service.

A distinction should be made between unattended automatic stations and remotely supervised stations.

Remotely supervised stations are those which, although operation is automatic, the start and stop function is available at the controlling point.

Unattended Automatic Station. For the purposes of this article, an unattended automatic station is defined as one which operates automatically without remote supervision. For example, stations which operate from a pressure or flow signal, starting and stopping by signals at the local installation without remote control of the start and stop function are considered unattended automatic stations.

Unattended automatic stations are a more advanced form of the remotely supervised stations. Essentially they do their own thinking. This feature limits the flexibility and usefulness of this type of operation since the station must always act in a predetermined manner. The automatic sequence control of this type of station is more complex and this complexity increases with the number of units and the operating functions which must be considered. In view of these facts, unattended automatic stations can be used most readily as boosters on lines with fairly constant flow rates.

in Pump Station Automation?

the oil industry leads the field in remote supervisory control equipment.

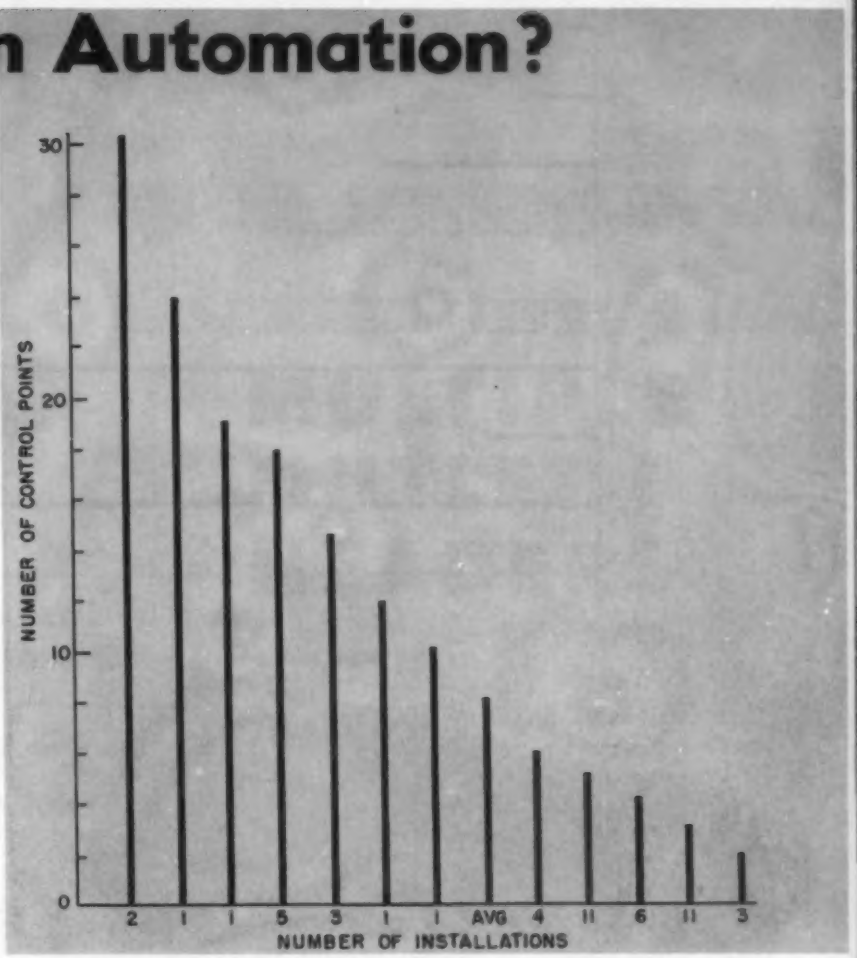


FIGURE 2—Number of control functions per installation averages 8.

REMOTELY SUPERVISED STATIONS

The following features give a specific picture of the presently installed systems. This pertains to those remotely supervised pipe line stations which are on trunk line service and does not include installations which are considered part of gathering systems.

Type of Supervisory Control System. Basically, there are two types of supervisory control systems. These are the relay type and the so-called tone type. At the present time 58 percent of the remotely-controlled stations utilize relay type supervisory equipment, with the remaining 42 percent being tone type supervisory equipment. On a company basis, 78 percent use relay type with 22 percent using tone type supervisory equipment. Included in the relay type designation are the installations using Bell telephone equipment.

There are in operation both relay type and tone type supervisory equipment which were designed and built within the operating companies organizations. There are seven stations of this type.

Relay type supervisory equipment usually utilizes a series of d-c pulses. Their signals are coded by varying the number of pulses or the length of the spaces between the pulses. These coded signals are received by a relay circuit chain which operates a specific control relay for a specific signal. Figure 4 illustrates one of the relay type supervisory control equipments.

Tone type supervisory equipment utilizes a signal consisting of either a series of audio tone pulses or a single pulse containing several audio tones. The coding is obtained by the presence or absence of various audio tones. These coded signals are received by frequency sensitive circuits which ultimately energize a specific relay for a specific signal.

Control Functions. The control functions which are available at the master station are defined such that the start and stop of a unit are two separate functions. This is to place all available systems on the same basis and to give a more accurate idea of the number of separate and distinct operations which have been used on the existing remote control systems.

Referring to Figure 2 it can be seen that the number of control functions per installation varies from a maximum of 30 to a minimum of 2, with the average number falling at 8. It should be noted that the older installations of supervisory equipment within the same company usually show 50 to 100 percent more points per unit than the newer installations. Approximately 80 percent of these stations are completely unattended and the remaining 20 percent are normally attended only part time, or the attending operator's main function is not the operation of the pumping units, but rather auxiliary terminal equipment.

Reliability. Reliability is defined as the percentage of time that the supervisory control equipment is available for operation. The answers which were received to this question vary from 100 percent availability to 90 percent availability, with the average being approximately 98 percent. In all instances this has proved to be at least as good as the connecting link used regardless of type.

The Connecting Link. The connecting link is defined as any means used to transmit the supervisory control signals from the remote location. The connecting links in use are:

1. Bell Telephone System
2. Private wire line
3. Microwave

The largest connecting link accounting for 52 percent of the existing installations is the Bell telephone system. This includes both telegraph type circuits and voice channels. The relay type supervisory control sometimes can utilize the less expensive telegraph type circuit, whereas the tone

Modern Station Design

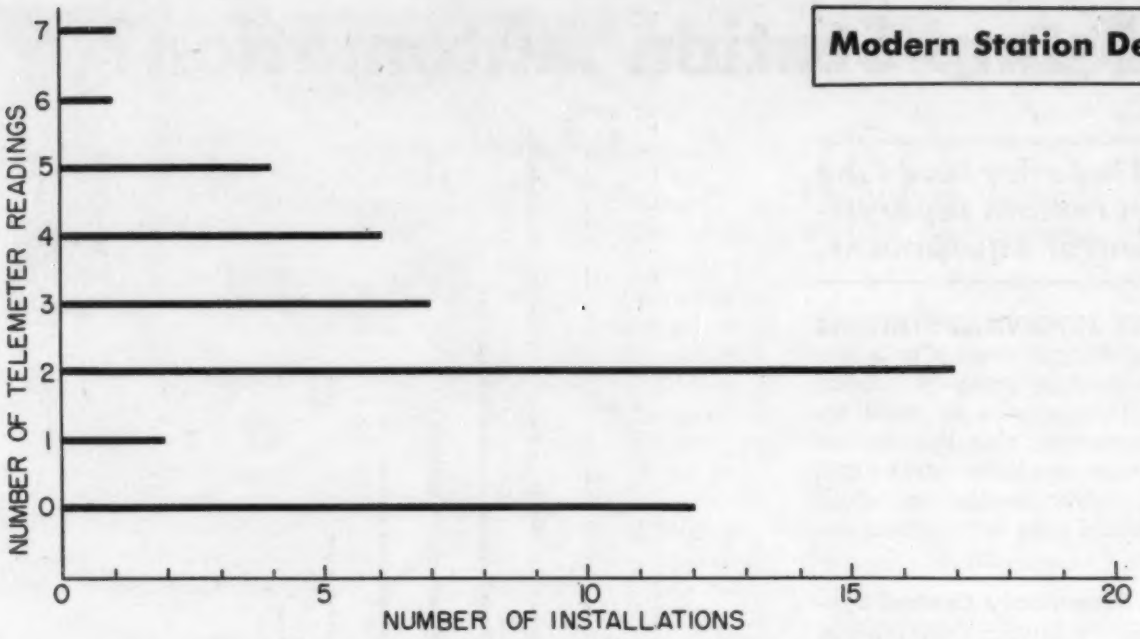


FIGURE 3—Number of telemeter readings in existing installations.

type supervisory control requires the more expensive voice channel.

Private wire line installations total 20 percent. The trend in this case seems to be that the pipe line companies are getting out of the pole and wire business.

Microwave is used in 28 percent of the existing installations. There is not sufficient data to indicate the existence of a trend in the use of this connecting link. In the installations covered by the survey, voice communications usually utilized more channels than the supervisory control functions.

The above percentage figures represent accurately the approximate pipe line mileage using these connecting links. On a company basis the connecting link usage is as follows:

Bell Telephone System 65 percent
Private wire line.....21 percent
Microwave .....14 percent

In some instances it may be considered expedient to place a number of remote installations on a common system similar to a party line. This can be done with either type of supervisory equipment. In this instance the relay type supervisory control usually requires some auxiliary audio tone equipment. See Figure 5.

Although there may be some slight economic advantage to a common system, it has some operational disadvantages. Principally, the loss of the common channel means complete loss of supervision. At the present time 62 percent of the existing installations are common systems. However, this represents the thinking of only 43 percent of the companies utilizing re-

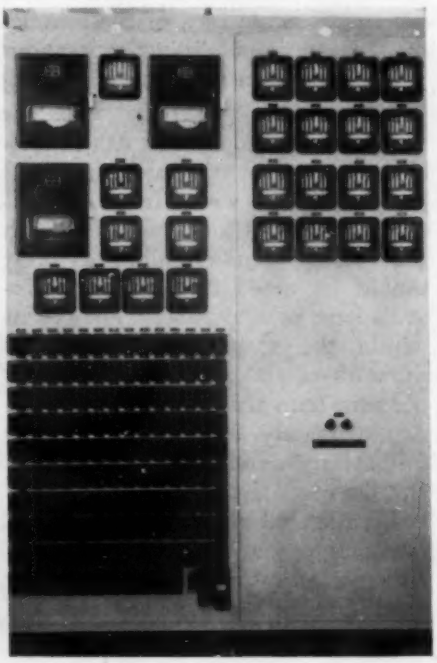
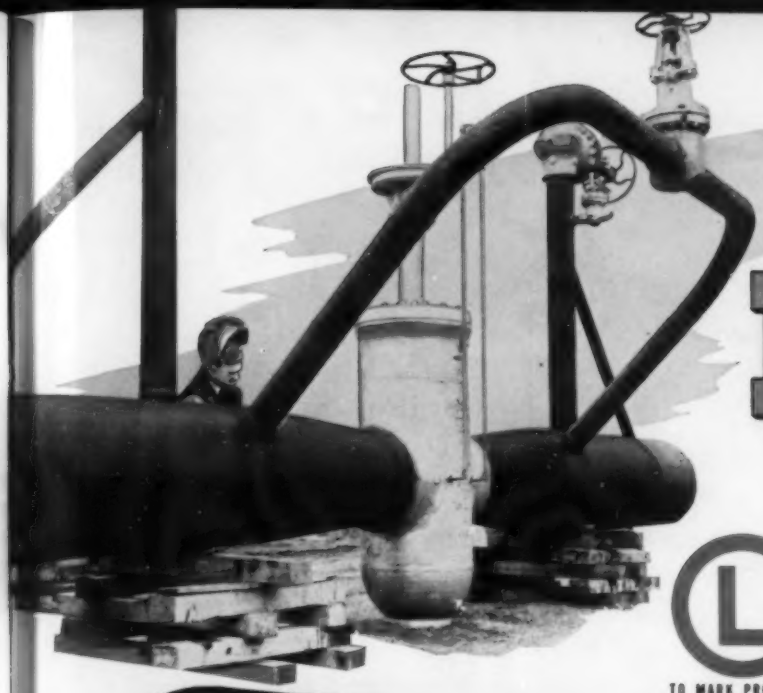


FIGURE 4—At left is dispatcher's supervisory control panel. At right is remote station's supervisory control panel.

FIGURE 5—Audio tone equipment shown assembled in rack mounting.



LADISH

MULTIPLE OUTLET HEADERS

TO MARK PROGRESS

Simplify

PIPE LINE GATE SETTINGS

Ladish Multiple Outlet Headers provide seamless outlets in exact location for by-pass, blow-down and service line connections . . . eliminate costly and undesirable practice of nozzling-in branch connections and saddle reinforcements.

Ladish headers . . . available in virtually any variation of size, number or location of outlets, diameter and length of run . . . are a significant development resulting from co-operation of pipe line engineers and Ladish engineering experience and manufacturing facilities.

Other Ladish developments for the Pipe Line Industry include—HOT TAP REINFORCING TEES, EXTRA LONG RADIUS (3R) ELBOWS, ANCHOR FLANGES.

- **Save 70% in Welding Time***
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- **Speed Construction**
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*REFERENCE: Panhandle Eastern Pipeline Co. article in March 7, 1955, Oil & Gas Journal. Reprints on request.

THE COMPLETE *Controlled Quality* FITTINGS LINE

LADISH CO.

CUDAHY, WISCONSIN
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District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland
Chicago • St. Paul • St. Louis • Atlanta • Houston • Odessa • Tulsa
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The dispatcher receives hourly reports on pressure, temperature, gravity, and rate-of-flow from each station on three pipe lines.

SOCONY MOBIL OIL COMPANY, INC., REPORTS:

One dispatcher controls three eastern pipe lines with Bell System private line telephone service

24 YEARS OF SATISFACTORY SERVICE

One dispatcher—in Plainfield, N. J. —controls 1077 miles of Socony Mobil pipe line in seven states, as shown on the map above.

He uses Bell System private line telephone service to get hourly reports on pressure, temperature, gravity, rate-of-flow and other operating information from as many as 60 points along the system.

Over the same facilities, he issues orders to cut in additional pumps or cut them off, run gasoline and distillates into tanks, or put products into the line from refineries.

Socony Mobil started using Bell System private line communications 24 years ago, and the company's growth has been accompanied by a corresponding growth in its communication system.

The Bell System can supply services to fit *your* exact communication needs, too. Just call your Bell Telephone representative for further information.

Socony Mobil uses these Bell System private line services:

Private line telephone service for pipe line dispatching and general administration.

Private line teletypewriter service for fast written communication between New York headquarters and the Paulsboro, N. J., refinery.

BELL TELEPHONE SYSTEM

TELEPHONE TELETYPEWRITER MOBILE RADIO TELEMETERING AND REMOTE CONTROL CHANNELS

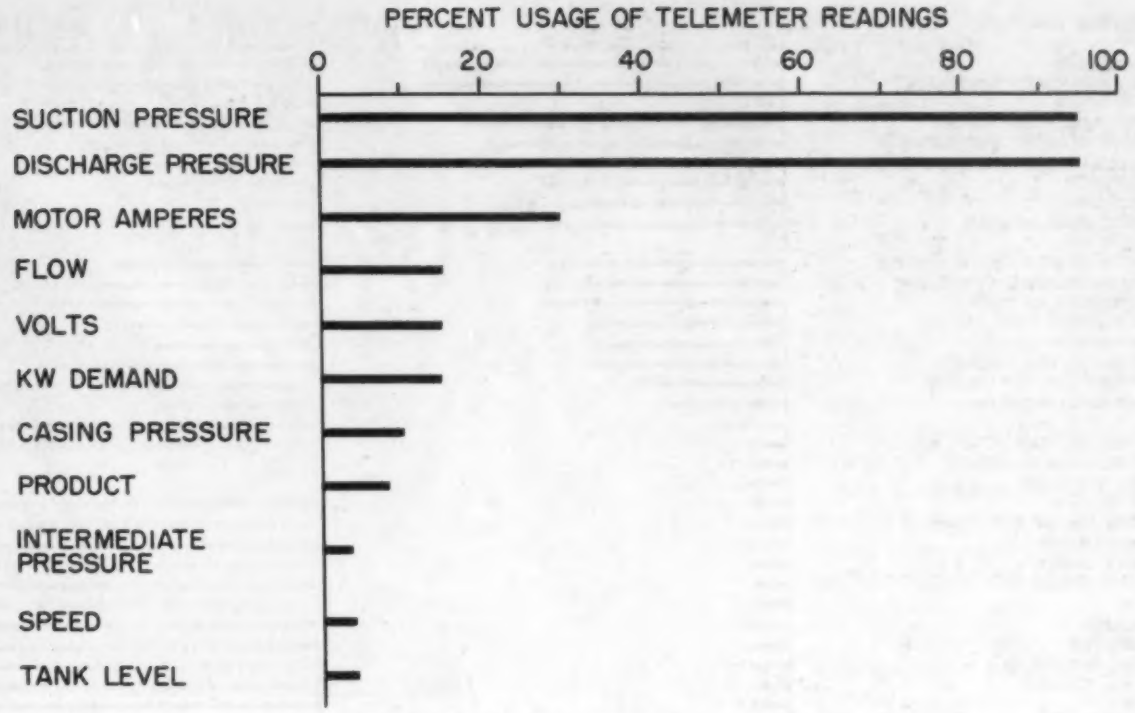


FIGURE 6—Percent usage of telemeter readings.

motely controlled systems. The trend seems to be toward controlling a larger number of stations from a central location.

Continuity. Continuity is defined as the method of operation which allows the remotely controlled station to continue to operate in a self-protected manner upon the loss of the supervisory control signal or the connecting channel. With only one exception, all of the presently installed remotely supervised installations continue to operate until the supervisory signal is available or until some trouble shuts the unit down.

Distances. There is considerable variation in the systems installed, the minimum distance appears to be ten miles with a maximum distance of 900 miles. The average distance from a control point to a remote installation is 100 miles. At the present time, the longest system utilizes Bell telephone system circuits. The longest system using microwave is approximately 750 miles.

Telemeter Equipments. Telemetering is defined as the remote reproduction of any measured quantity. Here again, there is a wide variation in the number of readings and also the types of readings which are utilized. For example, 25 percent of the installations have no telemeter readings whatsoever; 65 percent of the installations have four telemeter readings or less; and only 10 percent of the installations have five or more telemeter readings. See Figure 3. Of those that have telemeter readings, only 18 percent are available on a continuous basis, the others have installations where the desired telemeter reading is selected. Figure 6 indicates the telemeter readings which are in use and the percentage of installations which use specific readings.

Equipment Cost. This includes all of the supervisory control equipment and telemetering equipment excluding any of the automatic sequence control equipment which is installed at the station. Although this latter equipment is essential to the operation of the supervisory control equipment, the station is not operable remotely without the addition of the supervisory control and possibly telemetering equipment.

This is a difficult item to average out since the various installations have different number of points and utilize different supervisory systems. For example, those systems which use Bell telephone supervisory would not expect as large an equipment cost. This equipment must be rented on a monthly basis. This is factored in by capitalizing the yearly rental on a 20-year amortization basis.

Considering all these factors, an equipment cost per unit of installation (considering one motor and pump as a unit) would be approximately $9800 exclusive of the connecting link. This includes four telemetering readings, eight control points, and auxiliary equipment necessary for the proper functioning of the system.

Protective Functions. Protective functions are defined as those functions of a protective nature which are utilized in conjunction with any operating component of a pipe line station. Figure 7 lists the protective functions in use at the present time. It should be noted that this is an accumulation of designations rather than a list of necessary functions. For example, the protective functions listed as w, x, cc, dd, and ee are group type functions and include but do not identify many of the other individual type functions listed.

When using Figure 7 the "percent usage" refers to the installations which have a protective function by that name. The "percent individual transmission" refers to the percentage of those installations which, when they use a specific function, transmit an individual indication to the master station.

It is not recommended that the information in this figure be used as a guide in determining which functions

Modern Station Design

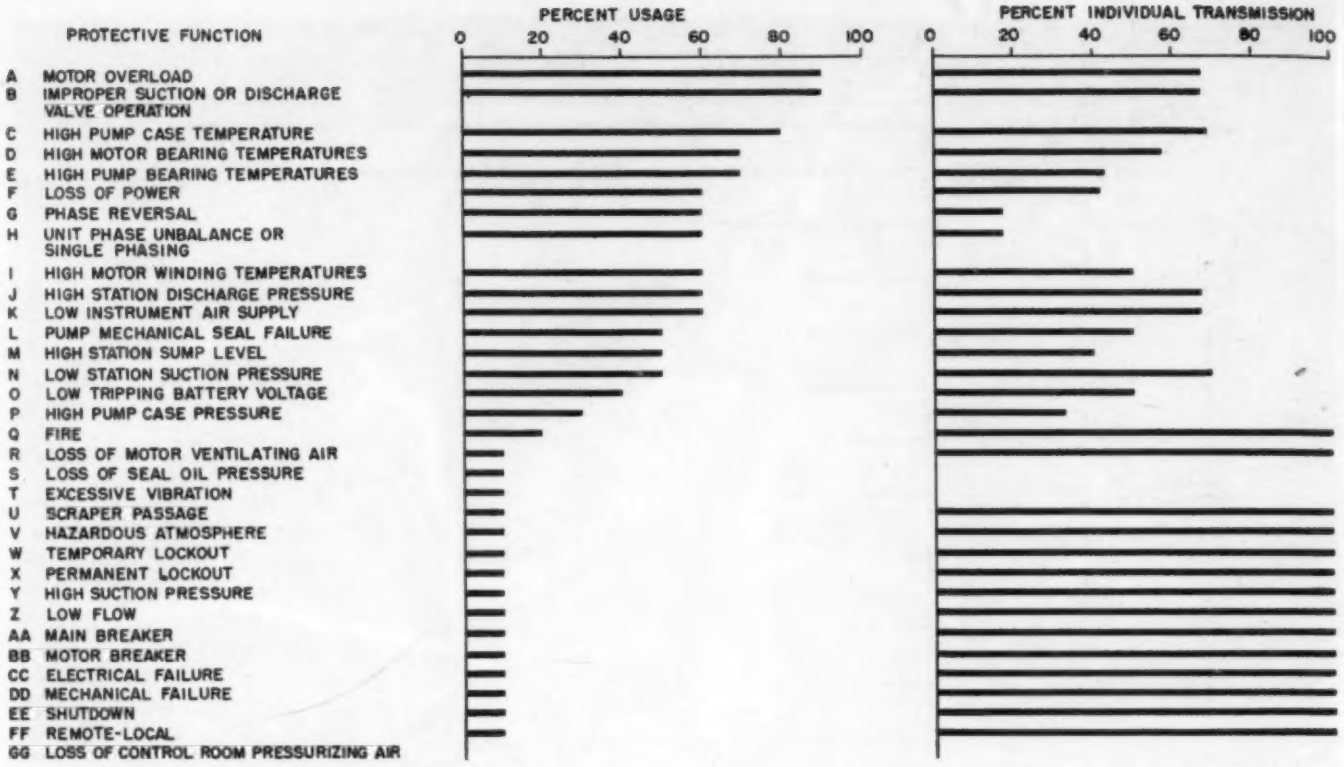

PROTECTIVE FUNCTION
PERCENT USAGE
0 20 40 60 80 100
PERCENT INDIVIDUAL TRANSMISSION
0 20 40 60 80 100
A MOTOR OVERLOAD
B IMPROPER SUCTION OR DISCHARGE VALVE OPERATION
C HIGH PUMP CASE TEMPERATURE
D HIGH MOTOR BEARING TEMPERATURES
E HIGH PUMP BEARING TEMPERATURES
F LOSS OF POWER
G PHASE REVERSAL
H UNIT PHASE UNBALANCE OR SINGLE PHASING
I HIGH MOTOR WINDING TEMPERATURES
J HIGH STATION DISCHARGE PRESSURE
K LOW INSTRUMENT AIR SUPPLY
L PUMP MECHANICAL SEAL FAILURE
M HIGH STATION SUMP LEVEL
N LOW STATION SUCTION PRESSURE
O LOW TRIPPING BATTERY VOLTAGE
P HIGH PUMP CASE PRESSURE
Q FIRE
R LOSS OF MOTOR VENTILATING AIR
S LOSS OF SEAL OIL PRESSURE
T EXCESSIVE VIBRATION
U SCRAPER PASSAGE
V HAZARDOUS ATMOSPHERE
W TEMPORARY LOCKOUT
X PERMANENT LOCKOUT
Y HIGH SUCTION PRESSURE
Z LOW FLOW
AA MAIN BREAKER
BB MOTOR BREAKER
CC ELECTRICAL FAILURE
DD MECHANICAL FAILURE
EE SHUTDOWN
FF REMOTE-LOCAL
GG LOSS OF CONTROL ROOM PRESSURIZING AIR

FIGURE 7—Protective functions in use, percent usage of each, and percent of which are individually transmitted to the controlling point.

are desirable. Each individual installation has to be considered on the basis of existing conditions. Basically the criterion should be: "Does it contribute to the information essential for intelligent operation?"

RECOMMENDED TYPICAL INSTALLATION

With the foregoing as background, the following features are recommended in a typical remotely supervised oil pipe line pumping station. It is assumed that the station is already set up for attended automatic operation as previously described.

Control Functions

1. Start and stop control and indication for each of the individual motor-pump units in the station.

2. Raise-Hold-Lower control of discharge pressure controller. These operations may not be required in the simpler booster stations.

Alarms

1. Electrical failure (common for all units in the station-manual reset).

2. Mechanical failure (common for all units in the station-manual reset).

3. Temporary shutdown (common for all units in the station-automatic reset).

Telemeter Readings

1. Station suction pressure.

2. Station discharge pressure.

3. Position of discharge pressure controller set point.

Individual pipe line operators may find it desirable to have additional control or indication functions but these are considered essential. This typical remotely supervised station (assuming a single motor-pump unit), has seven control, indication, and alarm points and three telemeter readings. The availability of the system operating over a 100-mile Bell telephone system link is approximately 98 percent. The telemeter readings are available on a select-as-desired basis. The complete equipment cost for the remote supervisory control system, excluding the connecting link, is approximately $7000.

Conclusion. The results which have been obtained with the use of the presently installed remotely supervised equipment are encouraging. The reliability of the equipment and the connecting link, the reasonable cost of the equipment, all encourage increased usage of this type of operation. An indication of this is shown by the fact that of the companies who are at present operating this type of system, 35 percent have stations in the planning stage, representing an increase of 65 percent over the total number of stations presently operating.

APPENDIX

The following list of articles will give the reader a good over-all description of specific installations and a general understanding of the problems encountered in applications of remote control techniques to oil pipe line systems.

1. Remotely Controlled Products Pipe Line Pump Stations, S. S. Smith. Pipe Line News, October, 1950, pp. 22-24, 36.

2. A Long Distance Multipoint Telemetering System Using Teletype Transmission, A. J. Hornfeck, G. R. Markow. AIEE Transactions, paper 52-197.

3. Microwave Control of Pump Station Raises Line Capacity at Minimum Cost, J. R. Ellis. Oil and Gas Journal, Nov. 17, 1952, pp. 258-259, 410-411.

4. First Radio Controlled Pump Stations Now in Operation, C. H. Hohnadel. World Oil, April, 1952, pp. 249-252.

5. New Developments in Remote Control of Pumping Stations, M. A. Hyde. Oil and Gas Journal, October, 1952, pp. 202-3, 227-39.

6. Automatic and Remote Control of Electrified Pipe Lines, B. M. Mills. AIEE Conference Paper, January 24, 1952.

7. Microwave for Pipeliners (Series) Supervisory Control and Telemetering, C. B. Lester. Pipe Line News, July, 1953, pp. A1-A8; August, 1953, pp. A1-A8; February, 1954, pp. 41-49.

8. Microwave Control of Pump Stations, R. C. Cheek. Pipe Line News, October, 1953, pp. S4-S12.

9. Leased Channels for Metering and Control, H. H. Joyner. Electric Light and Power, December, 1953.

10. Design of Automatic Pump Stations, Pressure Control of Single Unit, P. P. Plovanich, AIEE Conference Paper, September 27, 1954.

11. Basic Circuitry for Electrically-Powered Pipeline Pump Stations Under Automatic or Remote Control, M. A. Hyde, W. A. Derr. AIEE Transactions paper 55-63.

12. Remote Control by Microwave, P. J. Brewster, E. P. Lounsberry, J. B. Williams. Petroleum Engineer, April, 1955, pp. D23-D29.

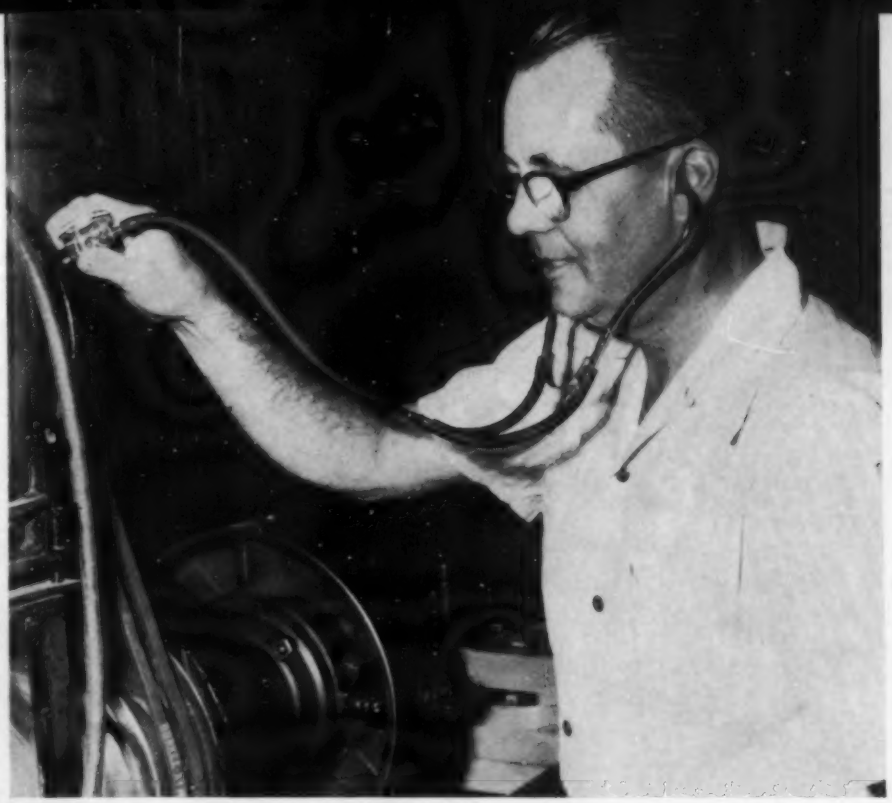
13. A New Centralized Control System to Handle Complex Dispatching, P. K. Eckhardt. The Petroleum Engineer, February, 1955, pp. D6-D13.

14. Channels for Telemetering, Supervisory Control and Other Purposes, H. A. Rhodes, R. W. Ralston. National Telemetering Conference, May 18-20, 1955.

15. Remotely Controlled, Unattended Pumping Stations, T. V. Bockman, R. S. Cannon, 6th Products Pipeline Conference, API Division of Transportation, May 16, 1955.

ACKNOWLEDGMENT

Portions of this paper and illustrations were presented at the Electrical Conference of the Petroleum Industry, American Institute of Electrical Engineers, September 12-14, 1955, Houston.



Harold Brawner of Lone Star Gas Company's compressor station demonstrates a new use of the stethoscope developed there, to detect a development offbeat in compressor engine rhythm.

Engine "Doctor"

Stethoscope and thermometer tell when engine is sick.

A STETHOSCOPE, says the dictionary, is an apparatus for auscultation, consisting of a tubular or solid piece of wood or hard rubber to be applied to the patient's body, and tubes for conveying the sound to the examiner's ear or ears.

And auscultation, the book of definitions says, is the act, art or process of listening for sounds produced in the chest, abdomen, etc., to determine any abnormal condition.

but those definitions don't hold completely true at Lone Star Gas Company's Joshua Compressor station where a stethoscope hangs on the wall of the tool shed alongside of other mechanical instruments.

The stethoscope was put in use at the plant by Charlie Putman, superintendent. He picked it up at a sale of Army surplus goods. His theory was that if doctors could listen to the human heart with such an instrument and hear a fallacy in its almost inaudible thumping, then he should be able to detect a developing offbeat in the rhythm of a compressor engine.

His theory of preventive maintenance was tried and proved correct. And his idea could develop a new international use of the instrument.

But it all brings up another question. If the stethoscope's new use becomes general, should the instrument be renamed or the definition changed in the dictionary?

A highly sensitive pyrometer with a probe which can reach almost every part of an engine is saving time in labor in engine maintenance at the Joshua compressor station.

A touch of the pyrometer against the side of suction valve on a compressor station engine and the instrument will measure the amount of heat the valve produces.

If the pyrometer shows one particular valve is hotter than another, the valve with the highest temperature is running a fever. Something is wrong. Plant personnel can then set about to find the trouble, usually a broken valve.

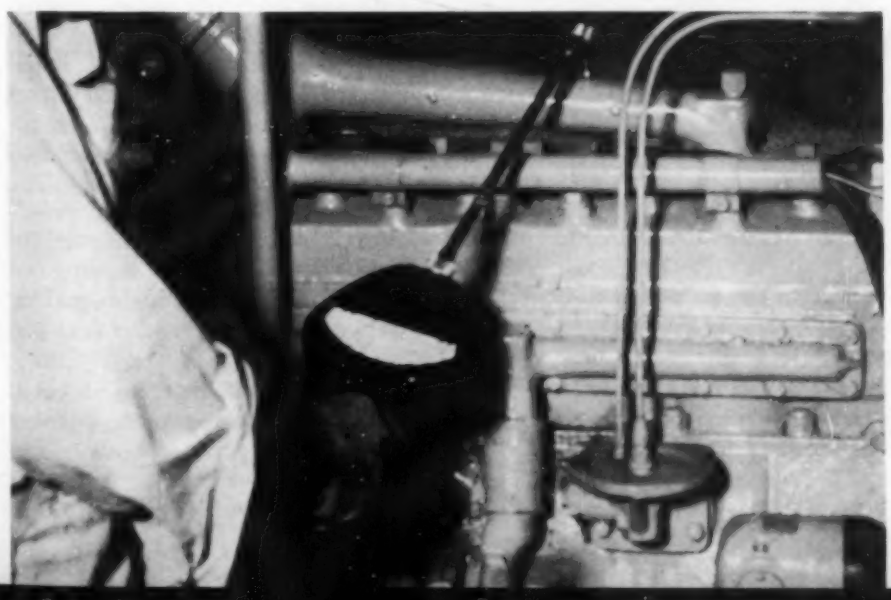
"It saves us a lot of trouble," says Harold Brawner, clerk A at Joshua. "We don't have to tear into a valve before we known something is wrong."

The pyrometer also will measure temperatures of water, exhausts, plastics and various other items. It will not measure human temperatures because it must contact metal to be active.

The pyrometer was purchased by the Joshua Compressor Station in August, 1953, and is now used at various plants. It will measure temperatures from zero to 500 degrees on one scale and from zero to 1500 degrees on another.

"We find it handy to measure exhaust temperatures," Seth Davis, repairman A, pointed out. A difference in exhaust temperatures usually means the wrong mixture in fuels on the hotter exhaust.

The "fever" of an engine is checked with a pyrometer. Temperature of engines and motors can help diagnose ailments. Fever in the human body is comparable idea.



ACKNOWLEDGMENT

Reprinted with permission of Lone Star Gas Company's *Blue Braze*.

Lower end of the 34-foot-long hinged bell, which closes around the pipe. Where the halves join they are sealed with foam rubber. Pumps keep bell

HOW A LINE WAS TAPPED UNDER

A hinged bell that works like a clam bucket may be the answer to hot-taps at sea.

By E. E. (Buster) CAMPBELL,
Magnolia Petroleum Company,
Morgan City, Louisiana

A 10¾-INCH PIPE LINE has been successfully hot-tapped 22 feet beneath the surface of the Gulf of Mexico in open water.

The tap was made inside a specially made hinged bell which closed around the pipe in much the same manner as a clam-bucket on a dragline.

This tap provided the most economical solution to the problem of tieing three shut-in gas-distillate wells into a pipe line. The wells had been completed on a platform in the Eugene Island area of the Gulf only 500 feet from a 10¾-inch gas and distillate line which had been laid before the wells were drilled. Three companies own interest in this line which is operated by Magnolia Petroleum Company. They are Newmont Oil Company, Continental Oil Company and Magnolia Petroleum Company.

The trouble was that the nearest connection on the line was about 13,000 feet from the production platform.

Three possible methods of tieing the wells into the line were considered. They were:

- To install about 13,000 feet of either 6⅝-inch OD or 8⅝-inch OD pipe from the wells to the connection on the line.
- To hot tap the line at a point near the platform, install a small structure to support the riser from the tap, and lay the 500 or 600 feet of 6⅝-inch OD pipe required to connect the wells into the tap.
- To uncover a sufficient length of the 10¾-inch OD line to pick it up above sea level, cut the line, and either loop the line over to the well platform or make a connection by which a 6⅝-inch OD line from the wells could be tied into the 10¾-inch OD line.

After considerable research, which included securing bids from a number of contractors, the second method was selected. A hot tap near the platform appeared to require less initial investment, and it provided a favorable point to tie these and other future wells into the line. This method was much cheaper than laying 2½ miles of pipe across the ocean floor.

Also it was believed that the experience gained from the tapping operation would be valuable in making future repairs and connections on other offshore lines.

Buried line difficult to locate. After the decision to tap the line was reached, the tapping operation was

evacuated during operations. Above is view of the upper end of the bell. It's 6 by 8 feet wide. Windlass in foreground is used to close the lower end.

22 FEET OF WATER IN THE GULF

delayed due to difficulty experienced in locating the line. The buoys originally placed on the line at the time it was installed four years previously, had been washed away by wave action or torn loose by boat traffic.

The approximate location of the line was known but several devices used to attempt to pinpoint the location were unsuccessful.

A mine-locating type detector failed to follow the line past the first anode bed. The electrical impulses fed into the line could be readily followed up to the bed, but past it there was no perceptible sign.

A fathometer reported to be capable of picking up varying densities of shallow underlying formations also failed as did geophysical geophones which were dragged across the line while sonic vibrations were fed into the line 13,000 feet away.

Eventually the line was found by pulling a hook-shaped jet plow across the Gulf floor.

After the line was buoyed at the exact point desired, a contract was made with Brown & Root, Inc., for making the tap, erecting the structure and laying the necessary pipe.

The diving bell used was some 34 feet long and was approximately 6 feet by 8 feet. It was made of ⅜-inch steel with the necessary bracing inside to give it sufficient strength to withstand the water pressure at this depth. The bell was made in two pieces, hinged at the top with a 10 inch opening, approximately 4 feet above the bottom for the pipe line. The seal between the bell opening was angle iron padded with foam rubber.

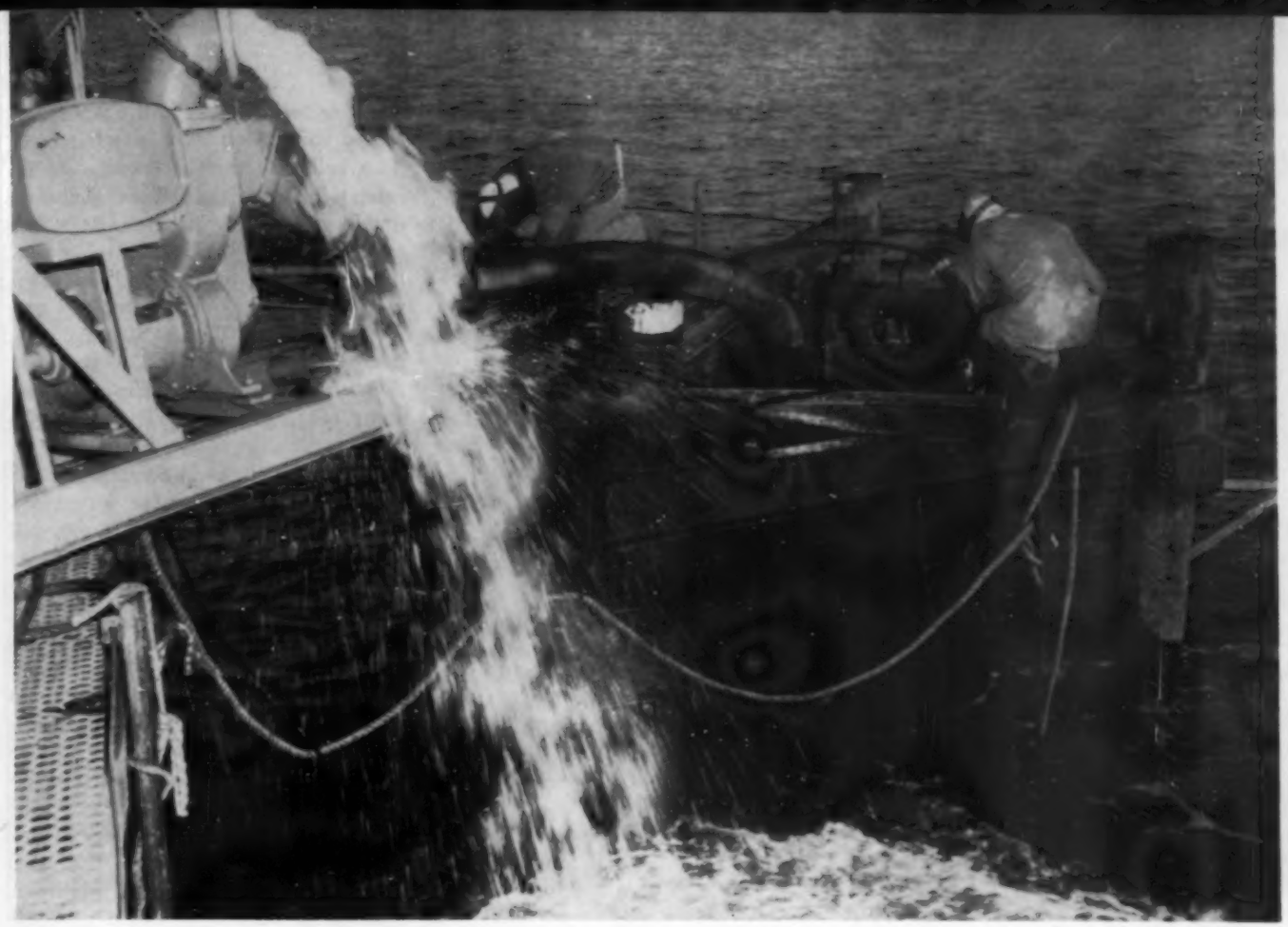
This bell had been used previously in shallow lake water to repair leaks but had never been used in the open Gulf waters. Preliminary calculations showed the buoyancy of the bell would be in excess of 30 tons, when evacuated. We considered weighting the bell to prevent damage to the pipe but decided it would be better to drive piling which could be used to hold the bell down as well as make the bell rigid against wave action and currents.

The effect of wave action and currents on the bell was one of the factors we were doubtful about. It was found the four 12-inch piling did have sufficient stability to hold the bell securely against normal wave action and currents, and hold the bell down, and prevent strain on the line.

The tapping operation was started on September 8. A deep water jet suction barge was used to make the evacuation around the 10-inch line and cut the pipe line ditch. Two cuts were made on the pipe line ditch which provided a ditch approximately 6 feet deep. The jetting on the 10-inch line was completed at 9:15 AM on September 9, and the diver reported the line 4 feet below normal Gulf bottom and the excavation at the tap site was approximately 9 x 20 x 9 feet deep. The jet barge was moved off location and lay barge moved on location. The 10-inch line was taken out of service and the pressure lowered. This was done for ad-

Attempting to close bell over pipe in open sea. Two foot waves kept the bell moving, so it was withdrawn and pile braces were driven.

Piling was driven and then the bell was welded to the pipe piles to withstand the great buoyancy.



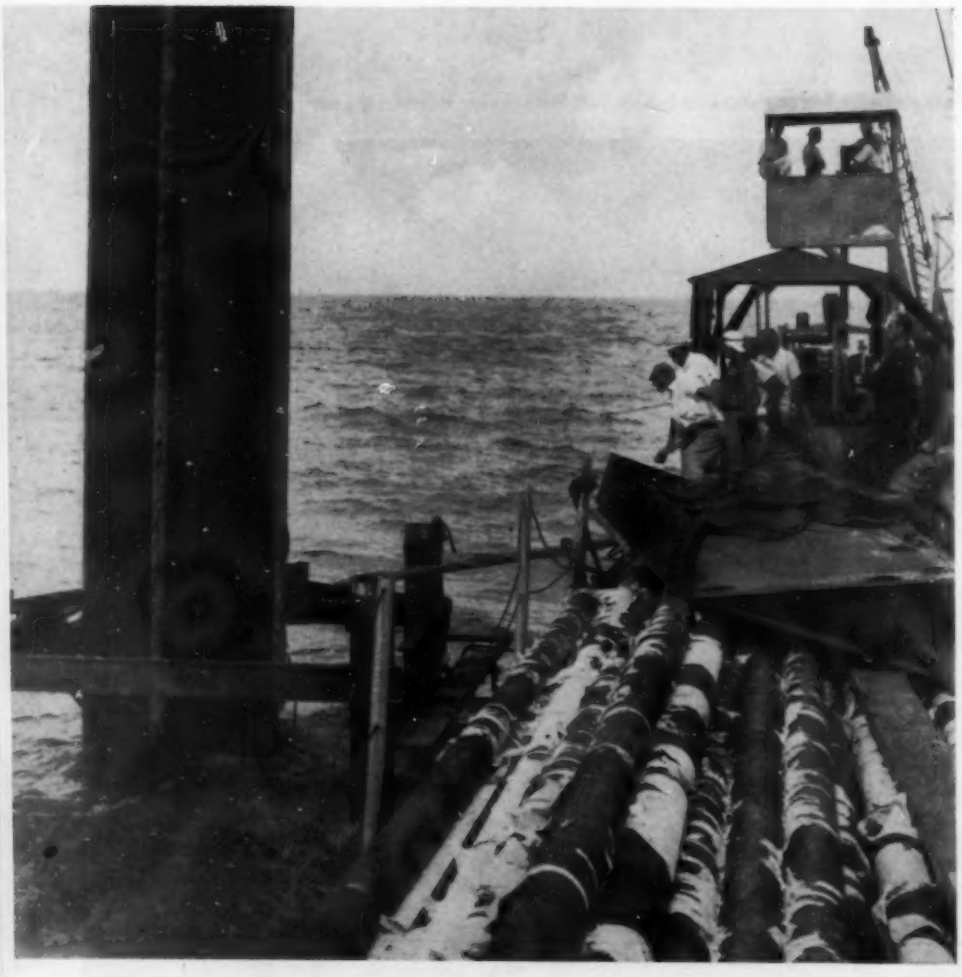
Bell is evacuated; as water lowered, diver stuffed rags in chinks to prevent water spray. Once pipe was clear, pumps easily maintained water level.

The flange has been saddled onto the pipe and the next step is to bolt on full opening valve for the hot-tap.

ditional safety of men working in the bell during welding and tapping operation.

At 2 PM, the first attempt was made to place the diving bell in position. The bell could not be kept open wide enough to fit over the 10-inch line. Cables had been attached to the bottom of the bell with a pulley arrangement to hold the bottom of the bell open. The wave action prevented this from working, so the bell was removed from the water and straps welded on it to prop it open. The bell was then lowered over the line, the straps cut off by the diver and began closing the bell. At 4 PM, the bell was fully closed and a side-boom attached to the bell. The crane was disconnected from the bell and preparations made for driving temporary 12-inch pilings. The wave action was causing considerable movement of the bell and hammering it against the side of the barge. One of the hand winches was damaged so the bell was let down under water, letting it pivot around the line to avoid movement caused by the waves. At 7:20 PM an attempt was made to set the first 12-inch temporary piling. The bell was lifted to a vertical position to aid in correctly positioning piling, but the bell was subject to so much movement it was lowered again to prevent further damage. The diver made several attempts to position the piling for driving but could not hold the piling in place due to barge movement and wave action on the pile. The sea was 2 to 3 feet at this time. Operations were shut down at 9:30 PM, waiting on weather.

Down goes the six-inch riser after the hot-tap was made and the coupon recovered. In photo below, after the riser was bolted on, the hinges on the bell were cut, and the two halves were removed.



On September 10 a template was fabricated and attached to the barge for positioning and driving the piling. The barge was positioned by the diver and the first piling driven at 10 AM. The piling was driven to 40-foot penetration, another piling was driven and the bell raised to a vertical position. The north side of the bell was open. An attempt was made to close it with the hand winch and the cable and the hand winch broke. The bell was removed from the line, temporary piling driven and operations, shut down waiting for calm weather.

On September 14, the sea was calm with 1-foot swells. Work was resumed and the bell set on the line without incident. The excavation around the line had not filled in during waiting period. The 10-inch I-beam bracing was installed between the piling and around the bell and I-beam bracing placed diagonally between piling across the top of the bell. At 4:25 PM, crews began pumping out bell with 3 air-operated turbine pumps with diver attempting to plug off leaks. These pumps did not have the capacity to handle the amount of water leaking into the bell. At 4:25 pumping was resumed with a 6-inch centrifugal pump.

At 5:30 PM the water level was 17 feet below sea level with minor leaks in top of the bell and with no movement of the bell. The diver was still down plugging up leaks by punching rags into openings.

At 8 PM a centrifugal pump was lowered over the side of the barge by a sideboom tractor to decrease the lift. It lowered the water sufficiently to uncover the pipe line. The pump continued to handle water leaking into the bell during the welding and tapping operation. At 10:30 PM the welders started welding the flange onto the pipe line.

It was necessary to cover the weld and welders with a tarp to prevent water spray from top of the bell getting on the weld. An air hose was used to disperse the welding fumes.

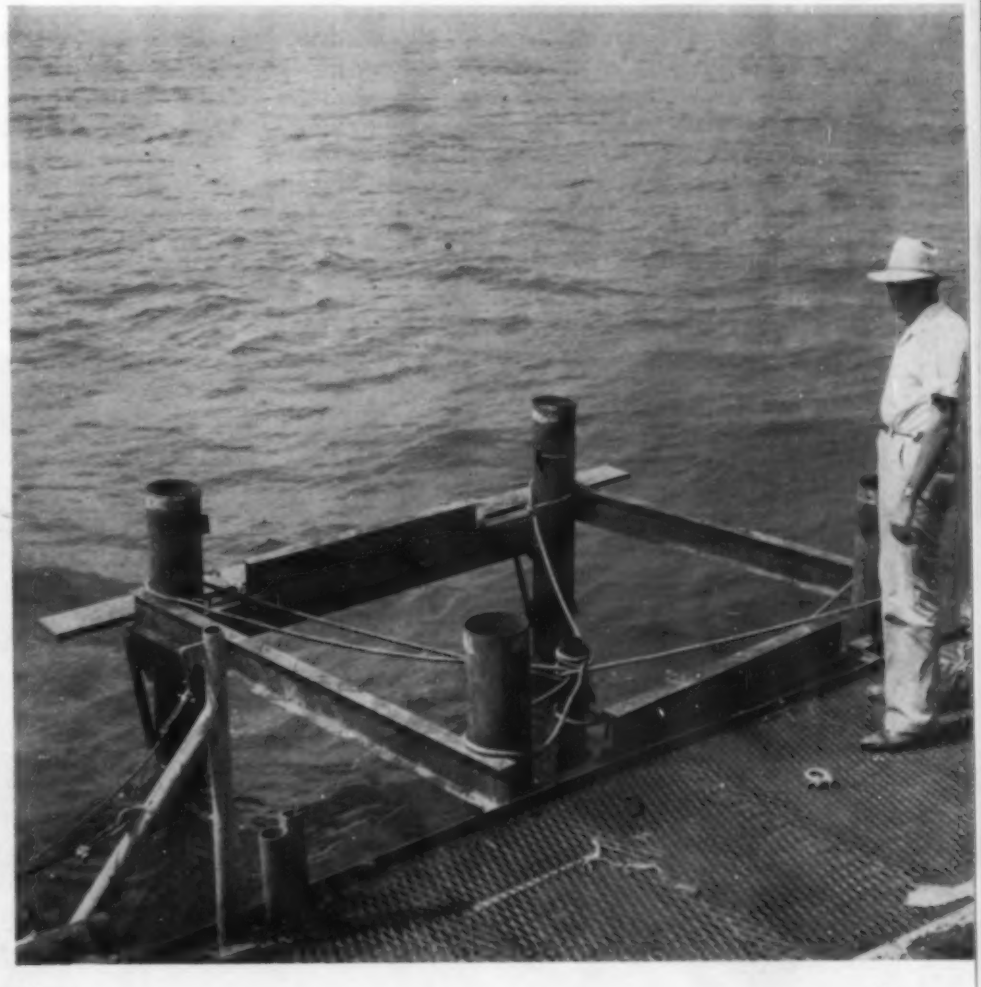
The welding operation was completed at 12:30 AM September 15 and the valve installed. The tapping operation was started at 2:30 AM and completed in 45 minutes. The coupon was recovered.

At 4:30 the riser was installed and coating repaired. The sea had picked up to approximately 2 feet and it was decided to discontinue operations until daylight. At 7:30 AM removal of the bell from the tap was begun. The bracing over the bell was removed and the bell cut in two sections by removing the pivot arm at the top. The bottom of the half of bell removed was pulled away from the line by a cable attached to the bottom of the bell and the bell lifted out through the 10-inch I-beam bracing around the bell. The remaining half of the bell was cut loose from the bracing and was removed at 9 AM.

The diver reported no damage to the line, valve, or riser. The lay barge was then moved into position to lay the 6-inch line. This was completed on the morning of September 16.

The protective structure was then set over the tap and the piling driven. The structure could not be set on the bottom as the hole around the tap was too deep and uneven. Instead it was welded to the 12-inch temporary piling for support until the permanent piling were driven and the structure welded to the piling. The temporary piling had been placed to fit the permanent structure so this could be done if the excavation did not fill in sufficiently to permit setting the structure on the bottom. These pilings were cut off at the Gulf bottom by the diver when the structure was set. On September 17, crews continued driving piling with the sea 2 to 3 feet. Operations were discontinued at 4 PM on September 17 because of rough seas and were not resumed until September 22. The job was completed on September 23 and the equipment moved off location at noon.

—The End



Template for the permanent structure fits outside the temporary pile bracing used for the tap. Template was temporarily welded to the piling, and then permanent piling was driven through the four corners. Then the temporary piles were cut loose and removed. In photo below, the hot-tap is complete and ready for the permanent structure.

June Ballard volunteered to go through the pipe when the nylon-coated line inside the pipe broke in the middle of the river. Here, Ballard is entering the pipe on the west bank, pulling a cable he will fasten to the broken end.

Texas Eastern's new dual 30-inch Mississippi

Gyroscopic 'Mole' Surveys Pipe Line

By MELVIN A. JUDAH,
PIPE LINE INDUSTRY Staff

WHEN TEXAS EASTERN recently completed a crossing of the Mississippi River near New Roads, La., company officials wanted to make sure of the exact location of the dual 30-inch crossing. To make a survey they called in a company which had done research aimed at adapting oil well survey instruments to pipe line applications. From the results of this survey they hope to have an accurate record of the location of the line in the event of future repairs or legal responsibilities.

As river crossings go, the New Roads crossing was a relatively simple one. It is located at a point on the Mississippi just a few hundred yards below a crossing of Transcontinental Gas Pipe Line Corporation. At low water, the river is about 2800 feet wide here and the line measures about 3200 feet between the overbends on the two banks. The west bank approach rises over a levee about 200 feet back from the bank overbend. At mean low water the river is about 30

1. First step in the survey run through the pipe line is to orient the "mole" on the end of the pipe on the opposite bank.

2. After the gyroscopic element is oriented, the instrument is placed in the case and secured for the survey pull.

River crossing near New Roads, La.

Two and a half hours later, Ballard emerges on the eastern bank 3400 feet away after fastening the two ends together 50 feet under the river. The cable that he fastened pulled the "mole" through the line for two survey runs.

Under Mississippi

feet deep and the bottom at this point is fairly smooth deepening slightly at the eastern side. In actual survey, the "mole" traveled 3484 feet on each leg of its round trip through the pipe.

The 30-inch pipe used for the crossing has a wall thickness of 0.625-inch. It was coated and weighted with a 2½-inch coating of barite concrete. The concrete coating increased the weight of the finished river line to about 500 pounds per foot. Pipe was laid from a ramp type barge into a dredged ditch and covered with a minimum of 15 feet of backfill on the bottom.

Before the survey job actually began, the crew ran into some difficulty. The nylon coated cable which was being pulled through the line by a pig became fouled and parted. At this point, a human "mole," June Ballard of Houston, volunteerd to go through the pipe line. He pulled the rest of the cable through behind him and fastened the two ends together in the pipe nearly 50 feet under the river. When

3. The actual survey starts as the "mole" is inserted in the pipe line.

4. Operation of the winches on the opposite banks must be carefully coordinated. Bill Krueger uses radio to control the operations.

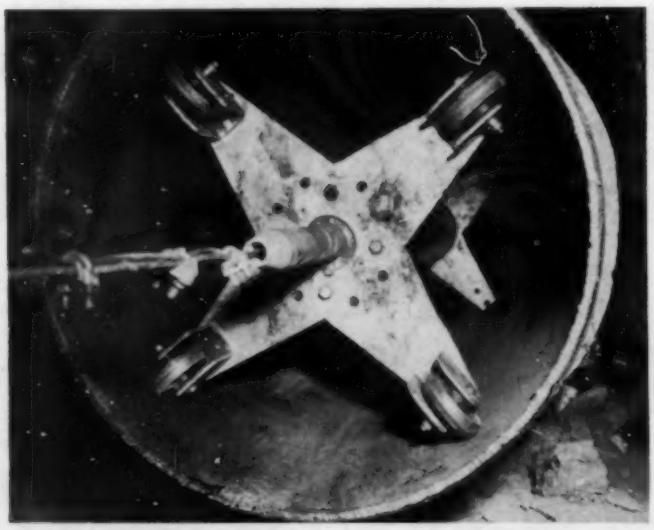
the job of splicing the cable was finished he came out on the east side of the river two and a half hours later. It was Ballard's second "submarine" job; he had crawled under the Achtafalaya River in south Louisiana last summer to speed a similar survey.

Once the "mole" was hooked to the winch cables on each bank, the first leg of the survey began from the east bank to the west. The pipe line survey instrument consists of a gyroscopic element used to determine the direction of the line, a pendulus inclinometer to measure the deviation from horizontal, and a timing mechanism and flashing light system working in conjunction with a motor-driven 16mm movie camera.

Pictures of the instruments were taken within the "mole" every 15 seconds during the pass through the line. The instrument was stopped at 40-foot intervals in its travel except at sharp changes in direction where it was stopped every 10 feet to record the attitude of the instruments. Radio communications directed work between winch teams on the two banks. When the east to west run was completed the "mole" was pulled through the line backwards for a check run.

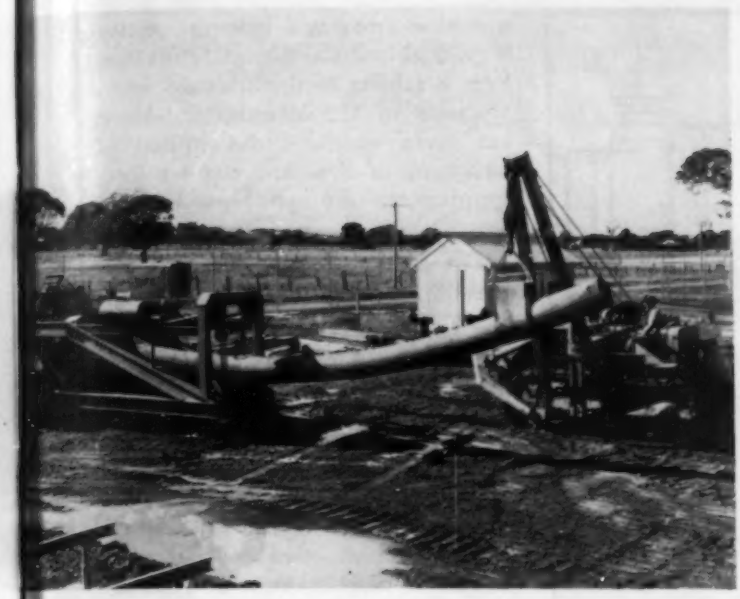
With the field survey of the main line completed, film was developed and calculations began to give a permanent record of the location of Texas Eastern's main line under the Mississippi. Soon afterwards, the survey crew will shift upstream to survey the auxiliary line, too. **—The End**

5. A friction type counter measures the length of cable payed out to determine the instruments position in the line.



6. When the "mole" reaches the opposite river bank, winches are reversed and the check run is made back through the line. The survey is nearly complete, except for one step.

7. Final step in field survey is to orient the gyroscopic element again on the opposite end of pipe. Technician sights down instrument at auto lights spotted on the far bank.



Pipe bending machine imported from U. S. bends uncoated pipes to be used in high-pressure gas pipe line from Morwell to Melbourne, a distance of 103 miles.

Sideboom (above) lowers in a length of the 18-inch pipe. A pause for refreshments (below) before laying pipe in four-foot ditch. After pickling and priming with a coal tar primer, pipe was coated with coal tar enamel, reinforced with fiber glass and overlaid with coal tar enamel and asbestos felt.

Photos Courtesy *The Age*, Melbourne

New Australian Line Carries Coal Gas

This 18-inch line was completed at a mile-a-day rate, using U. S. methods and equipment.

THE GAS AND FUEL Corporation of Melbourne Victoria is erecting a Lurgi gas producing plant at Morwell Victoria, 103 miles from Melbourne, to produce gas from the huge deposits of low grade brown coal located in the Latrobe Valley, and estimated at 22,000 million tons.

When produced, the gas is to be piped to Melbourne through a high pressure pipe line, now being laid, at a pressure of 425 psi.

It was considered more economical to pipe the gas than transport the coal to Melbourne by rail.

The pipe line is in two sections. The first from Morwell to Dandenong, a distance of 75 miles, is the high pressure section and the second, the low pressure or distribution section from Mandenong to Melbourne. The pipe line was laid at the rate of a mile a day using equipment and methods common in the U. S.

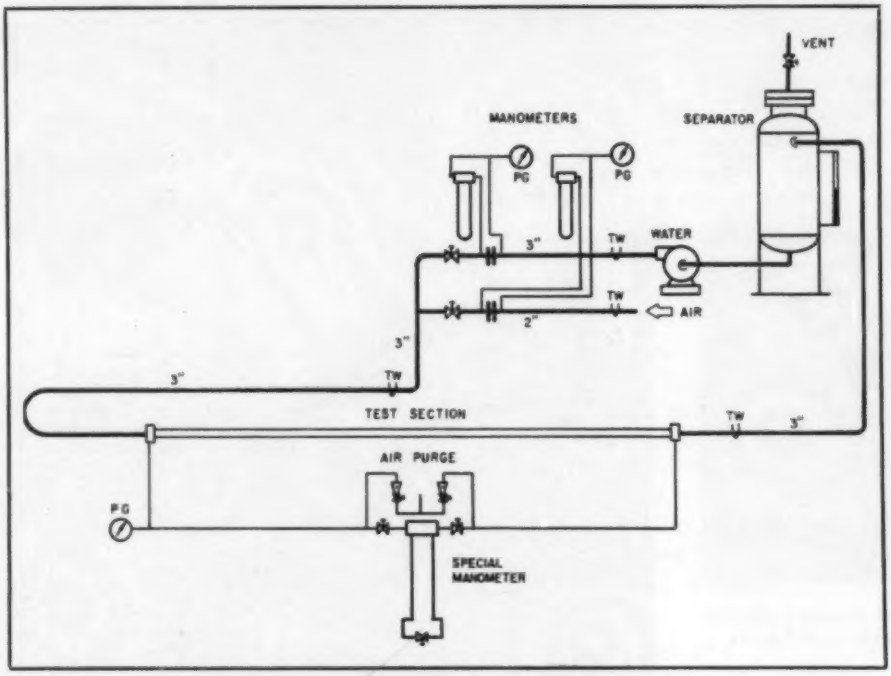


FIGURE 1—Flow diagram of apparatus.

How to calculate . . .

Turbulent Two-Phase Flow

Based on 264 runs in larger pipes and at pressures to 100 psia, this correlation gives better results.

By J. M. CHENOWETH and M. W. MARTIN,
C F Braun & Company, Alhambra, Calif.

IN MANY industrial plants, gases and liquids flow together in pipes as a two-phase mixture. For example, two-phase mixtures of petroleum fractions pass through fired-heater tubes and transfer line in refineries. Gas and liquid mixtures are circulated together in pipe line contactors in chemical plants. And mixtures of partially condensed vapors flow through condensate lines in steam and refrigeration plants. For all of these cases and many more, the engineer needs to be able to predict pressure drop.

Pressure-drop computations for two-phase flow are more complex than for single-phase flow. The introduction of a second phase causes a sharp rise in the pressure drop because of one or more of the following factors: The cross-section for flow of the one phase is reduced by the introduction of the second. The flow boundary is no longer a relatively smooth pipe wall, but is a rough, irregular, mobile interface between phases. And the introduction of the second phase can cause a very unsteady flow accompanied by intense turbulence.

The many types of two-phase flow further complicate pressure-drop computations. Altogether, seven different types have been observed in horizontal pipes. In order of their appearance with increasing gas rate, they are called bubble flow, plug flow, layered flow, wavy flow, slug flow, annular flow, and misting flow. The transition from one type to another is gradual and the boundary between each is subject to the arbitrary interpretation of the investigator. Alves[1] has given excellent descriptions of each type of flow and has set forth approximate boundaries between types.

The most generally accepted correlation for predicting two-phase flow pressure drop is the method of Lockhart and Martinelli.[2] This method was developed from data for small-diameter pipes and for pressures from atmospheric to 50 pounds per square inch gauge. But many applications of two-phase flow fall beyond these limits. This investigation was undertaken to check the Lockhart and Martinelli correlation with pressure-drop data for two-phase flow in larger pipes and at higher pressures.

Apparatus and Tests—Equipment was set up to get isothermal-flow data for air-water mixtures. Figure 1 shows the arrangement of the test section, the system for mixing and circulating the fluids, and the means for measuring pressures, temperatures, and flow rates. Liquid was circulated by a centrifugal pump capable of delivering 200 gallons per minute at a 50-foot head. Compressed air was available at 125 psig in quantities to 750 scfm. Both streams were metered and the flow rates adjusted by manual control valves. The streams were brought together in a mixing tee with the water flowing down through a 3-inch run and the air entering through a 2-inch branch. The mixture then flowed some 50 feet through a 3-inch supply line before entering the test section. Upon leaving the test section, the mixture flowed to a separator where the air was vented through a pressure-control valve and the water was returned to the pump for recirculation. Two interchangeable test sections were used. One was made from 1½-inch and the other from 3-inch schedule 40, galvanized steel pipe.

Single-Phase Tests—Both test sections were checked with water to determine the single-phase friction factors. Figure 2 shows the experimental friction factors plotted against Reynolds number for the range of 20,000 to 200,000. The 1½-inch test section gave friction factors within plus or minus 7 percent of the smooth-

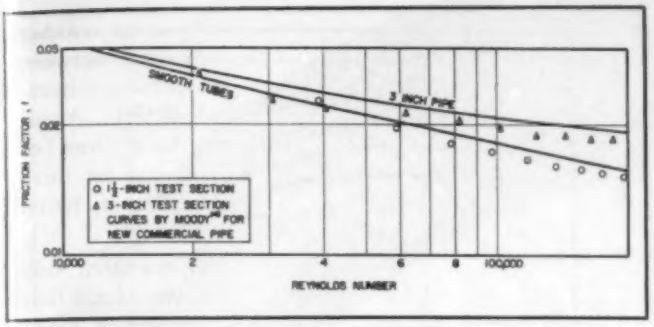


FIGURE 2—Single-phase calibration of test sections.

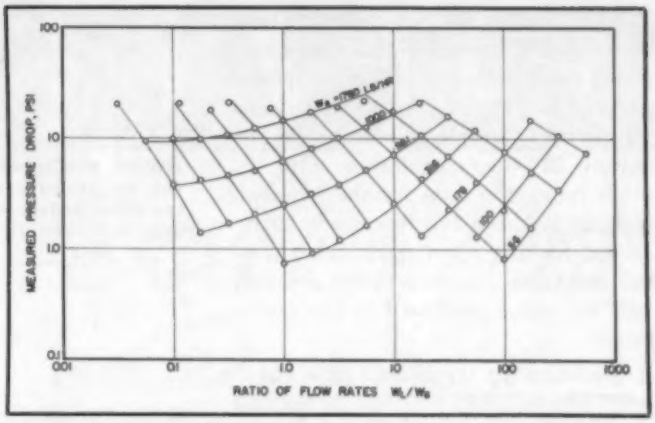
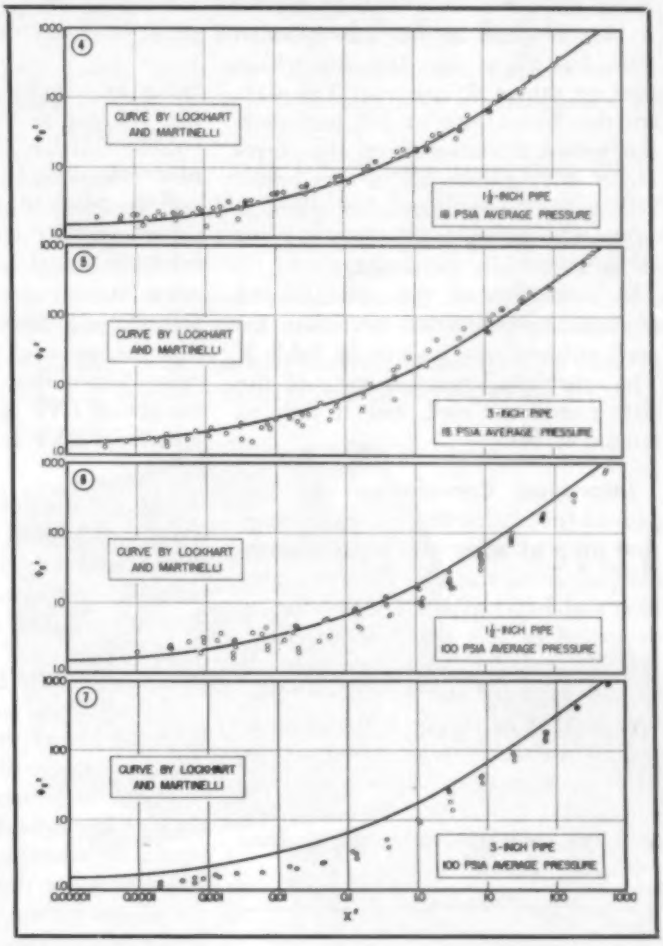


FIGURE 3 (above)—Cross-plot of measured pressure drops for tests in the 1½-inch pipe with an average pressure of 18 psia.



FIGURES 4, 5, 6 and 7 (right)—Test data compared with the turbulent-two-phase curve for the Lockhart and Martinelli correlation.

tube curve by Moody.[4] The pipe was new, and the visual inspection showed the pipe to be very smooth. The 3-inch test section gave friction factors about 8 percent below Moody's curve for 3-inch commercial pipe. Again the pipe was new and appeared quite smooth.

Two-Phase Tests—During the experimental program 264 isothermal two-phase pressure-drop tests were made, covering the range of variables listed in Table 1. All of the data were checked for consistency by plotting measured pressure drops versus the ratio W_L/W_G, the liquid to the gas flow rates. Figure 3 is such a plot showing the data for the series of tests made with the 1½-inch pipe near atmospheric pressure. The other test series produced similar plots. From these plots, the pressure drop was found to increase smoothly as either the gas or liquid rate increased. There were no sharp breaks in the curves, even though the tests included layered, wavy, slugging, misting, and annular flows.

Old Correlation—The correlation that has received widest acceptance is the one developed by Lockhart and Martinelli.[2] Their tests were made with air and various liquids flowing through pipes ranging in size from capillaries up to 1 inch diameter, and at pressures from atmospheric up to 50 pounds per square inch gauge. The present data are shown in the Lockhart and Martinelli correlation in Figures 4 through 7.

TABLE 1
Range of Test Conditions

Series*	Investigator	Pipe Size, Inches	FLUIDS	Average Pressure, Psia	Liquid Flow Rate, Lb./Hr.	Gas Flow Rate, Lb./Hr.
1	Authors	1.602	Water and Air	18	100—31,600	56—1,780
2	Authors	1.602	Water and Air	100	100—31,600	56—3,160
3	Authors	3.072	Water and Air	18	100—31,600	56—3,160
4	Authors	3.072	Water and Air	100	100—31,600	56—3,160
5	T. H. M. Taylor	1.017	Diesel Oil and Air	18	2020—4,380	20— 247
6	T. H. M. Taylor	1.017	Kerosene and Air	18	641—12,900	21— 210
7	T. H. M. Taylor	1.017	Water and Air	18	289—15,200	11— 226
8	T. H. M. Taylor	1.017	Water+Nekal and Air	18	450—15,900	15— 248
9	R. W. Ravenscroft	0.622	Water and Air	50	210— 317	41— 99
10	E. G. Thomsen	0.622	Water and Air	52	300	36— 101
11	E. G. Thomsen	0.622	Water+Kemenol and Air	52	191— 315	24— 102
12	E. G. Thomsen	0.622	Benzene and Air	52	141— 273	17— 102
13	A. H. Abou-Sabe	0.870	Water and Air	18	975—15,000	4— 201
14	G. E. Alves	1.049	Water and Air	24	485— 8,400	10— 196

*Series numbers are used for identification in Table 4.

TABLE 2
Comparison of Test Data with Lockhart and Martinelli Correlation

Pipe Size, Inches	Average Pressure, Psia	PERCENT AVERAGE DEVIATION	
		Absolute	Algebraic*
1.602	18	19.2	4.0
1.602	100	38.6	28.9
3.072	18	21.9	— 8.9
3.072	100	75.3	—42.3
All Tests		35.5	—16.7

* Minus sign indicates measured pressure drop is less than predicted pressure drop.

The data for the 1½-inch pipe near atmospheric pressure fall generally along the correlation. All of the points are within plus 28 percent and minus 49 percent, which is within the accuracy of the correlation. On the other hand, the data for the 1½-inch pipe at 100 psia fall below the correlation, for the most part. Several of the measured pressure drops are only half the value predicted by the correlation.

The data for the 3-inch pipe tested near atmospheric pressure again fall along the correlation. The agreement is not as good as for the 1½-inch tests, but all of the data are within plus or minus 60 percent. The data for the 3-inch pipe at 100 psia show the widest deviation from the correlation with almost all of the points falling low. The correlation predicts pressure drops up to 2.5 times as great as those actually measured.

A tabulation of the absolute and algebraic averages of deviation for each series of tests is given in Table 2. The correlation handles some of the flow conditions well, but it fails to handle others.

Improved Correlation—An improved correlation for two-phase pressure drop in horizontal pipes was developed from the test data for 1½-inch and 3-inch pipes. The correlation presented in this paper is empirical, just as all earlier ones have been. It can be used for any two-phase mixture as long as the flow is turbulent, and it predicts single-phase values when the flow is all liquid or all gas.

The correlation uses the liquid volume fraction and two pressure-drop ratios as parameters. Figure 8 shows the abscissa as the superficial liquid volume fraction, or LVF, of the mixture computed from the flow rates and densities of the two phases. The superficial LVF may be quite different from the actual LVF since the phases often travel at different velocities. Johnson and Abou-Sabe[5] pointed out that the gas may travel as much as 7 times faster than the liquid. Since the actual LVF is seldom known, the superficial LVF is used for this correlation.

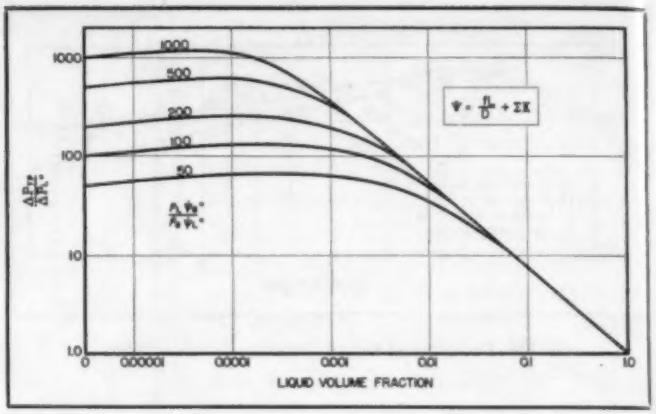


FIGURE 8—Correlation for turbulent two-phase pressure drop in horizontal pipes.

The ordinate of Figure 8 is $\Delta P_{TP}/\Delta P_L{}^*$, the ratio of the two-phase pressure drop to a fictitious all-liquid pressure drop. The all-liquid pressure drop is computed from the total mass flow $(W_L + W_G)$ and the physical properties of the liquid. The concept of the all-liquid pressure drop is useful as it allows the correlation to be tied into single-phase results at one end and eliminates any ambiguity about the physical properties to use, especially viscosity. Further, the all-liquid pressure drop was chosen over the all-gas pressure drop, because the liquid density generally does not vary in a problem, while the gas density changes with the pressure. Thus, only one single-phase pressure drop need be computed.

On the grid are plotted a family of curves for the parameter $\rho_L\psi_G{}^*/\rho_G\psi_L{}^*$, where $\psi = fL/D + \Sigma K$. The parameter is equal to the ratio of the fictitious all-gas to all-liquid pressure drops for the pipe system.

$$\frac{\Delta P_{G^*}}{\Delta P_{L^*}} = \frac{\left[\frac{f_{G^*}L}{D} + \Sigma K\right]\left[\frac{W_L + W_G}{A}\right]^2\left[\frac{1}{2g\,\rho_G}\right]}{\left[\frac{f_{L^*}L}{D} + \Sigma K\right]\left[\frac{W_L + W_G}{A}\right]^2\left[\frac{1}{2g\,\rho_L}\right]} \qquad (1)$$

The subscripts with asterisks, L* and G*, refer to the fictitious all-liquid and all-gas flows, respectively, and the subscripts without asterisks, L and G, refer to the actual liquid and gas flows. Canceling out like terms in the equation and substituting

$$\frac{\Delta P_{G^*}}{\Delta P_{L^*}} = \frac{\left[\frac{f_{G^*}L}{D} + \Sigma K\right]}{\left[\frac{f_{L^*}L}{D} + \Sigma K\right]}\,\frac{\rho_L}{\rho_G} = \frac{\psi_{G^*}\,\rho_L}{\psi_{L^*}\,\rho_G} \qquad (2)$$

The friction factors are those from the Moody chart[4] for single-phase flow plotted against Reynolds number. To determine the Reynolds number for f_{L^*}, the sum of the flow rates and the physical properties of the liquid phase are used

$$Re_{L^*} = \frac{DG}{\mu_L} = \frac{D\,(W_L + W_G)}{\mu_L A} \qquad (3)$$

For f_{G^*} the physical properties of the gas phase are used. The K's are the friction coefficients for valves and fittings. A complete list of values is given in The Tentative Standard of the Hydraulic Institute.[6] The coordinates for the correlation are listed in Table 3.

The correlation covers all turbulent two-phase mixtures and ties into single-phase values at either end. When the flow is all liquid, the LVF equals 1.0 and the ratio $\Delta P_{TP}/\Delta P_{L^*}$ is also equal to 1.0. On the other hand, when the flow is all gas, the LVF is zero and the ratio $\Delta P_{TP}/\Delta P_{L^*}$ is equal to $\Delta P_G/\Delta P_L{}^*$, so the pressure drop equals $\Delta P_L{}^* \times \Delta P_G/\Delta P_L{}^* = \Delta P_G$

Two-phase pressure drops predicted by this correlation are plotted against measured pressure drops in Figure 9. Over 92 percent of the calculated ΔP are within 35 percent of the measured values and all are within 50 percent. The deviation for each point was com-

TABLE 3

Coordinates for Proposed Correlation

	$\Delta P_{TP}/\Delta P_L{}^*$				
	$\rho_L\psi_G{}^*/\rho_G\psi_L{}^*$				
LVF	50.0	100	200	500	1000
0	50.0	100	200	500	1000
.00001	56.5	113	225	565	1125
.00002	58.5	117	235	585	1175
.00004	62.0	124	248	620	1230
.00007	63.5	127	254	635	1200
.0001	64.5	129	258	645	1150
.0002	66.0	132	255	580	950
.0004	67.5	129	249	470	680
.0007	65.0	121	219	385	470
.001	62.0	115	199	325	370
.002	58.0	99.0	153	215	215
.004	50.0	82.0	105	120	120
.007	41.0	60.0	71.0	72.5	72.5
.01	34.5	48.0	53.0	53.0	53.0
.02	24.0	29.2	29.2	29.2	29.2
.04	15.0	16.1	16.1	16.1	16.1
.07	9.90	9.90	9.90	9.90	9.90
.10	7.40	7.40	7.40	7.40	7.40
.20	4.05	4.05	4.05	4.05	4.05
.40	2.22	2.22	2.22	2.22	2.22
.70	1.38	1.38	1.38	1.38	1.38
1.00	1.00	1.00	1.00	1.00	1.00

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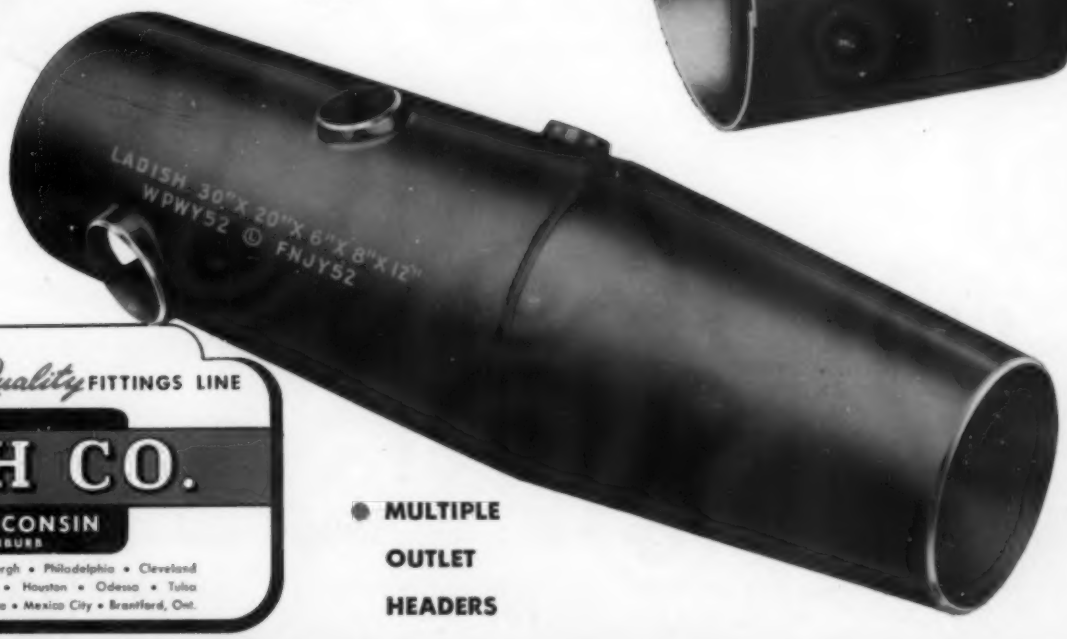

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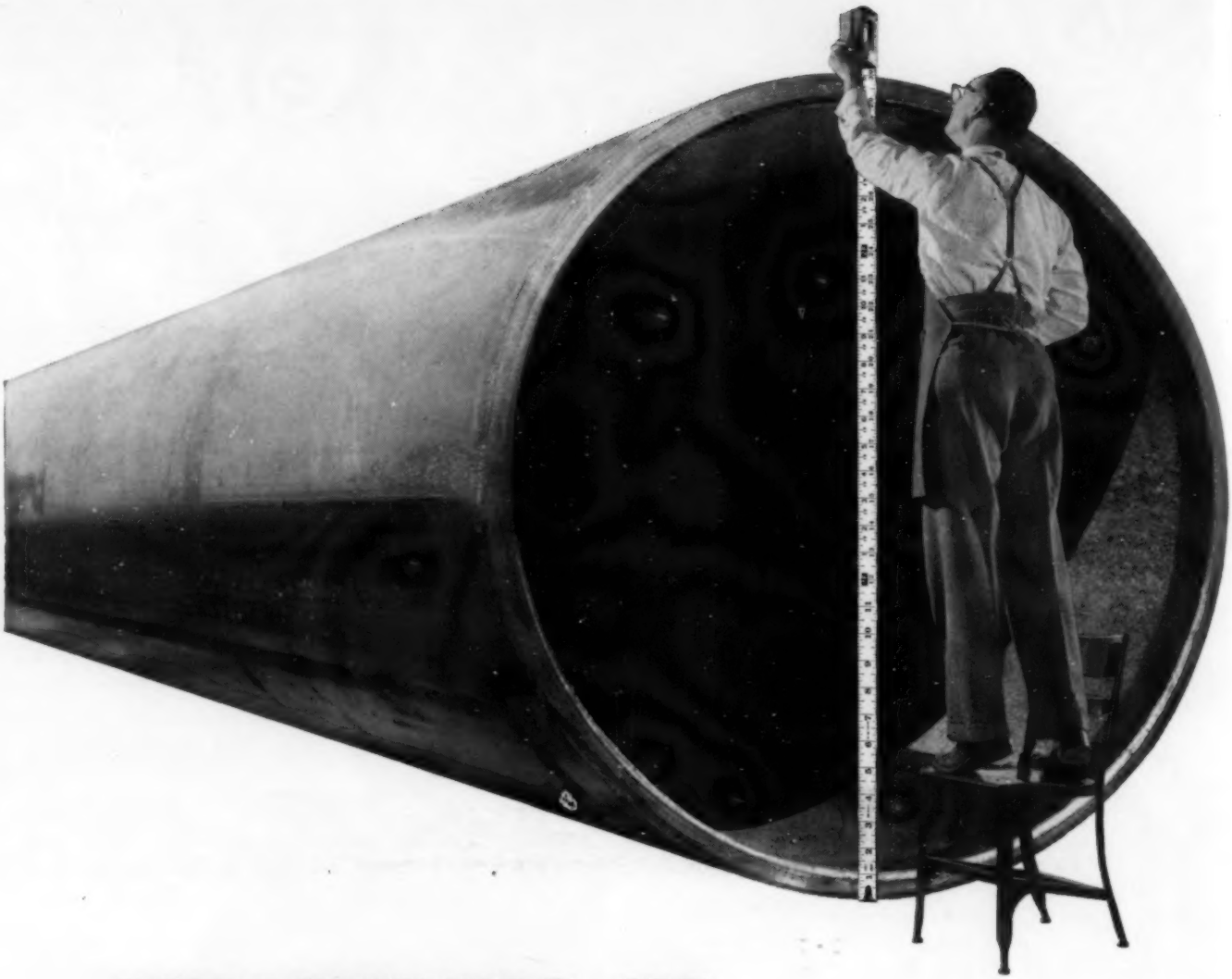

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Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, California
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, California
Electric Resistance Weld—Plain End	5⅝" to 12¾" O.D.	Up to 55'	.188" to .375"	Fontana, California
Electric Resistance Weld—Plain End	14" to 20" O.D.	Up to 40'	.250" to .500"	Napa, California
Electric Fusion Weld—Expanded—Plain End	20" to 30" O.D.	Up to 40'	.250" to .500"	Napa, California

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puted, and the absolute and the algebraic average of the deviations determined. The average of the absolute deviations is 19 percent while the algebraic average is 0.7 percent.

The correlation also fits the test results of other investigators. Table 4 lists the deviations from the isothermal turbulent-turbulent data of Johnson and Abou-Sabe,[5] Alves,[1] and those used by Lockhart and Martinelli[2] for developing their correlation. In all instances the average deviation of test data from the correlation is less than 30 percent. The over-all average of the absolute deviations is 20 percent and the algebraic average of the deviations is 5 percent. These results are for 506 different test runs in pipes from ½ to 3 inches diameter, pressures from atmospheric to 100 psia, and fluid-systems including air with water, kerosine, benzene, and diesel oil.

The correlation can be used to design most horizontal two-phase lines found in industrial plants. The only limitation is that the all-liquid Reynolds number must be greater than 2000. For flows with Reynolds numbers less than 2000 the correlation will, in general, predict pressure drops that are higher than actually exist.

The correlation is based on isothermal tests where there is no change of state as the mixture flows through the test section. The results, however, can be used to determine the the two-phase pressure drop for condensation and vaporization by a stepwise solution using point values taken from the correlation. The correlation is convenient to use for these problems as only one single-phase pressure drop need be computed. The results can then be multiplied by the proper $\Delta P_{TP}/\Delta P_{L\theta}$ as the LVF changes. It must be pointed out that the correlation gives only the friction pressure drop. Where there is a change of phase the pressure drop due to acceleration must also be considered.

Fittings—Piping systems include valves and fittings as well as lengths of straight pipe. Since very little information has been published on pressure losses for two-phase flow through fittings, several representative 3-inch fittings were tested. These included a

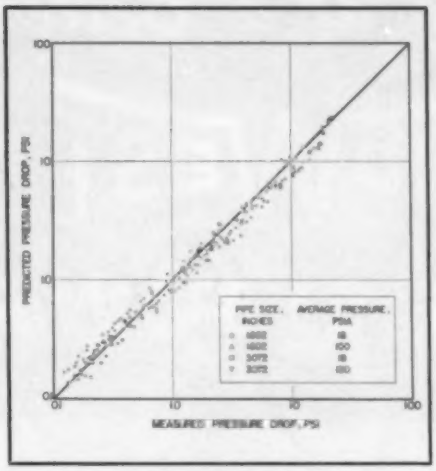


FIGURE 9—Test of correlation with data for horizontal pipe.

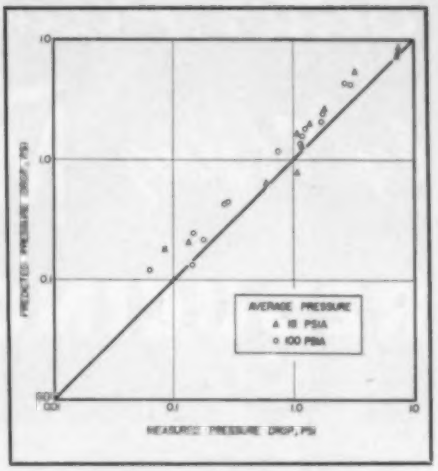


FIGURE 10—Test of correlation with data for a piping system containing an orifice. Pressure taps were located 38 diameters upstream and 38 diameters downstream of orifice. Single-phase friction coefficient for the orifice alone was 18.3.

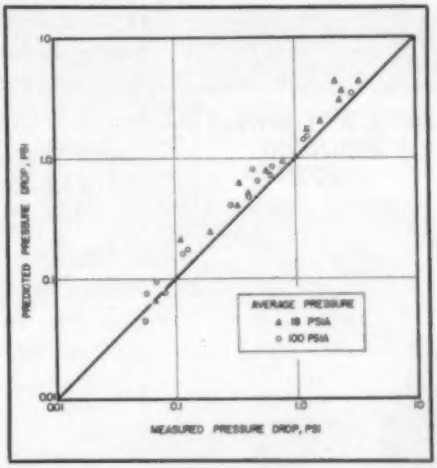


FIGURE 11—Test of correlation with data for a piping system containing a globe valve. Pressure taps were located 38 diameters upstream and 38 diameters downstream of the valve. The single-phase friction coefficient for the valve alone was 5.3.

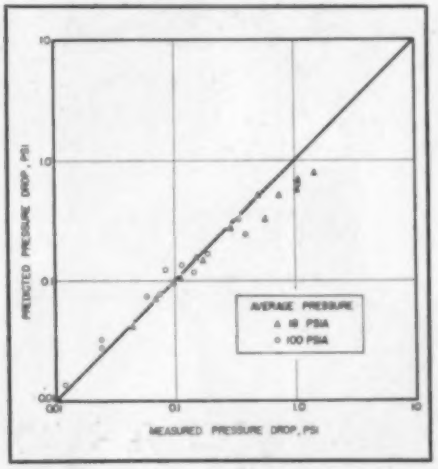


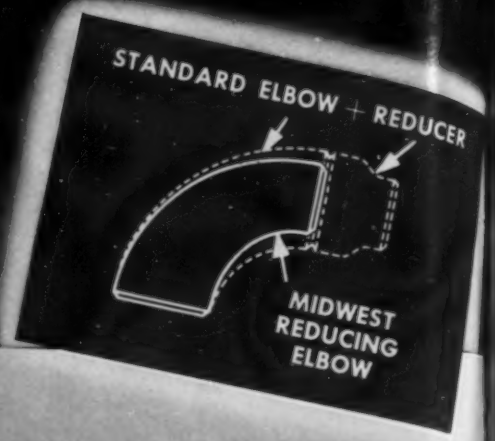
FIGURE 12—Test of correlation with data for piping system containing a long radius return bend. Pressure taps were located 10 diameters upstream and 30 diameters downstream of return bend. Single-phase friction coefficient for return bend alone was 0.3.

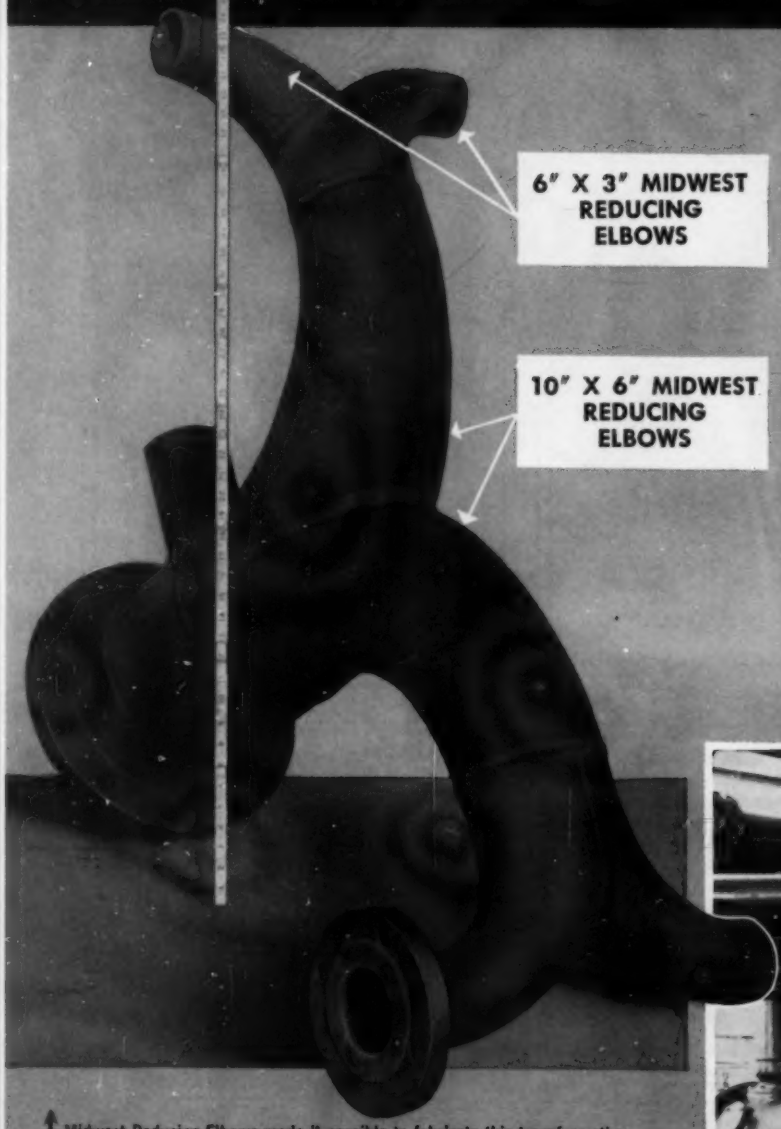
TABLE 4
Comparison of Test Data with Correlation

Series*	Investigator	Pipe Size, Inches	Average Pressure, Psia	Number of Tests	PERCENT AVERAGE DEVIATION	
					Absolute	Algebraic
1	Authors	1.602	18	71	14.9	0.1
2	Authors	1.602	100	74	19.9	4.8
3	Authors	3.072	18	71	23.2	—1.2
4	Authors	3.072	100	48	18.5	—9.8
				264	19.0	—0.7
5	T. H. M. Taylor	1.017	18	23	22.3	—22.3
6	T. H. M. Taylor	1.017	18	39	15.0	—12.2
7	T. H. M. Taylor	1.017	18	43	20.1	18.7
8	T. H. M. Taylor	1.017	18	26	22.9	16.5
9	R. W. Ravenscroft	0.622	50	9	21.8	20.7
10	E. G. Thomsen	0.622	52	7	20.8	20.8
11	E. G. Thomsen	0.622	52	19	25.7	25.7
12	E. G. Thomsen	0.622	52	23	25.2	24.4
13	A. H. Abou-Sabe	0.870	18	31	26.7	26.7
14	G. E. Alves	1.049	24	22	22.6	4.4
				242	22.0	14.1
	For All Tests			506	20.4	6.4

*Series numbers are used for identification in Table 1.

Better Piping at a Better Price by Using MIDWEST REDUCING ELBOWS

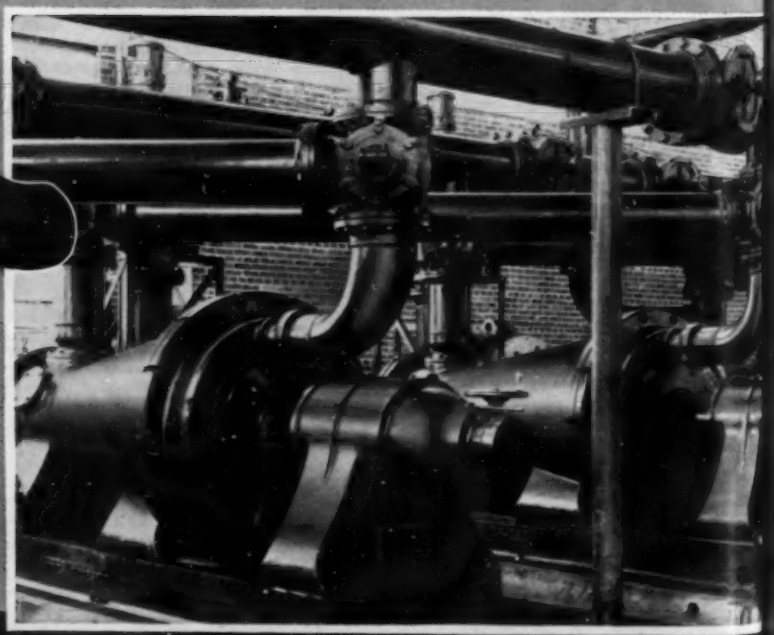




The Midwest Reducing Elbow offers important advantages in both piping design and piping cost. It needs only two welds instead of the three required by a standard elbow and a reducer (see sketch above). There is also a saving in layout time. Turbulence and pressure drop are reduced by the gradual taper . . . less space is needed . . . insulation is easier . . . and piping appearance is improved.

Only Midwest Reducing Elbows are available from stock in sizes to 16" . . . larger on special order. They have the same dimensional accuracy, uniformity of wall thickness, exact included angle and true center-to-end dimensions of Midwest Straight Elbows. For further information, ask for Catalog 54.

↑ Midwest Reducing Elbows made it possible to fabricate this transformation piece for a boiler feed suction line so that it could be installed in the limited space available and still get the benefit of streamline flow. There was also a cost saving in comparison with a less efficient and bulky assembly made with straight tees, ells and reducers.



→ Paper stock flows with minimum resistance through Midwest Reducing Elbows from 8" connection on Jordan to 10" header. Other advantages over standard elbow and reducer: a saving in cost and space, and improved appearance.

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composition-disk globe valve, a sharp-edge orifice with a diameter ratio of 0.55, and a long-radius return bend. Each fitting in turn was installed between the two halves of the 3-inch test section. Pressure drops were measured across the straight pipe and fitting so that all turbulence introduced by the fitting would be included. Both single-phase and two-phase tests were made with each fitting. The two-phase tests covered a wide range of flow rates for pressures from near atmospheric to 100 psia.

The measured pressure drops for the pipe and fitting are compared in Figures 10, 11, and 12 with pressure drops predicted by the proposed correlation using single-phase friction coefficients. In general, there appears to be a trend in the deviations. For the sections with the orifice and the globe valve, the predicted pressure drops are higher than measured values. These fittings promote mixing. On the other hand, for the section with the return bend, predicted pressure drops are often lower than measured values. In return bends the phases separate by centrifugal action. The data of Alves[1] show a similar trend for a 1-inch vertical return bend.

Although the trend is present, almost all of the predicted pressure drops agree within plus or minus 50 percent of measured values. Thus the correlation can be used to predict pressure drop for systems containing fittings by using single-phase friction coefficients.

About the Authors

Chenoweth

Martin

JAMES M. CHENOWETH has been a research engineer with C. F. Braun & Company since he received his doctor's degree from Purdue University in 1952. His specialties during this time have been in fluid mechanics and electronic-computer methods. Dr. Chenoweth also completed his bachelor's and master's degree at Purdue.

•

MERRITT W. MARTIN, formerly a group leader in the Research department of C. F. Braun & Company, now is with the Chemical Engineering department. While engaged in research for Braun, he gained six years' experience in problems of heat transfer and fluid flow. Holder of a master's degree in chemical engineering from the University of Texas, he worked three years on process development with The Dow Chemical Company.

Summary

1. Pressure drops have been measured for a wide range of two-phase flow conditions in horizontal pipes. The tests were made in 1½ and 3-inch pipes using air and water at pressures from atmospheric to 100 psia.

2. The data are compared with the Lockhart and Martinelli correlation. Best agreement is found for performance at atmospheric pressure. The largest deviations are for data taken at 100 psia in the 3-inch pipe. In this case, the predicted pressure drop is higher than the observed by a factor ranging from 1.4 to 2.5.

3. The test results were used to develop an improved correlation for turbulent two-phase flow in horizontal pipes. The correlation represents all of the experimental data within plus or minus 50 percent, and 92 percent of the data within 35 percent. The data of many other investigators correlate equally well. Coordinates for the correlation are listed in Table 3.

4. The test results for three typical 3-inch fittings show that single-phase friction coefficients can be used satisfactorily in the correlation for predicting the two-phase pressure drop.

Nomenclature

The following nomenclature is used in this article:

A — cross-sectional area of pipe, square feet

D — pipe diameter, feet

f — friction factor for Fanning equation, dimensionless

g — acceleration constant due to gravity, ft/sec²

G — mass flow rate, lb(mass)/sec ft²

K — friction coefficient for a valve or fitting, dimensionless

L — length of pipe, feet

R — bend radius, feet

Re — Reynolds number, dimensionless

W — flow rate of fluid, lb(mass)/sec

ΔP — pressure drop, lb(force)/ft²

μ — viscosity, lb(force)/ft sec

ρ — density, lb(mass)/ft³

ϕ — ratio $\sqrt{\Delta P_{TP}/\Delta P_{SP}}$, dimensionless. Ordinate for Lockhart and Martinelli correlation

X — ratio $\sqrt{\Delta P_l/\Delta P_g}$, dimensionless. Abscissa for Lockhart and Martinelli correlations.

ψ — Dimensionless group equal to $\frac{fL}{D} + \Sigma K$.

Subscripts

g — actual gas flow in total pipe cross section, used in Lockhart and Martinelli correlation

G — actual gas flow

G* — fictitious all-gas flow

l — actual liquid flow in total pipe cross section, used in Lockhart and Martinelli correlation

L — actual liquid flow

L* — fictitious all-liquid flow

SP — single-phase

TP — two-phase

tt — turbulent-turbulent flow, used in Lockhart and Martinelli correlation

ACKNOWLEDGMENT

Presented at the ASME Petroleum Mechanical Engineering Conference in New Orleans, La., September 25-28, 1955.

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[2] "Proposed Correlation of Data for Isothermal Two-Phase, Two-Component Flow in Pipes," by R. W. Lockhart and R. C. Martinelli, Chemical Engineering Progress, Vol. 45, 1949, pp. 39-48.

[3] "Fluid Meters, Their Theory and Application, Part I," ASME Special Research Committee on Fluid Meters, 4th ed., 1937.

[4] "Friction Factors for Pipe Flow," by L. F. Moody, Trans. ASME, Vol. 66, 1944, pp. 671-684.

[5] "Heat-Transfer and Pressure Drop for Turbulent Flow of Air-Water Mixtures in Horizontal Pipe," by H. A. Johnson and A. H. Abou-Sabe, Trans. ASME, Vol. 74, 1952, pp. 977-987.

[6] "The Tentative Standard of Hydraulic Institute, Pipe Friction," 90 West Street, New York, N. Y., 1948.

How to do it

PIPE LINE HINTS

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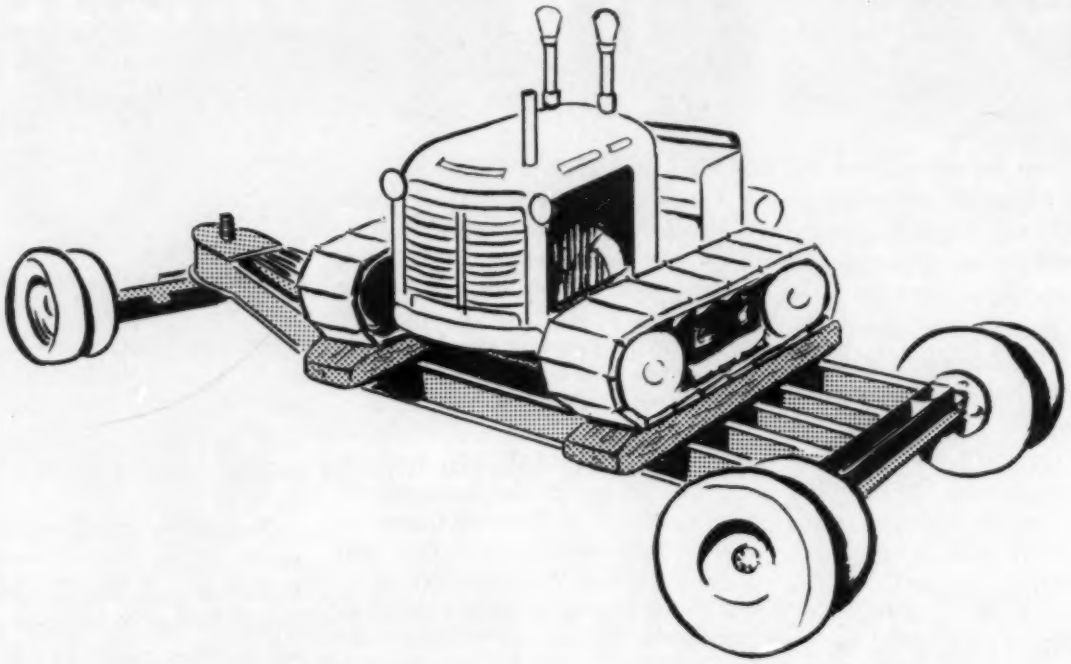
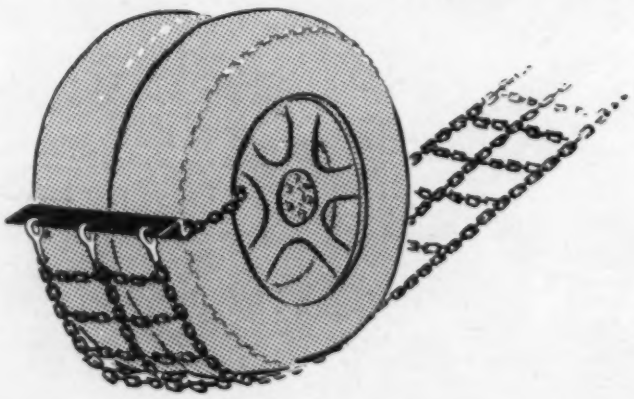


Fabricate a Rugged Low-Boy On Salvaged Truck Wheels

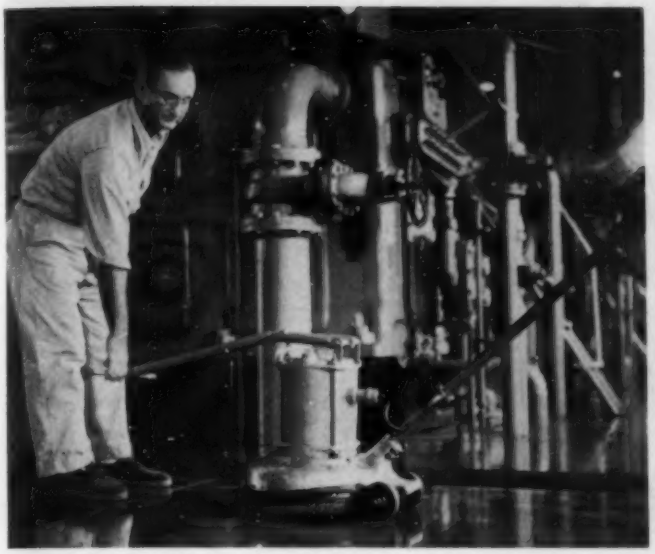
To move tractors about the line, one company built this low-boy in a station shop. Rear axles of a truck wheel set are replaced with channel beams. A beam is laid lengthwise down the center and two more welded on each side carry the tractor as shown. Beams are miter-welded near the front to permit the front wheels and tongue assembly to turn. Skids placed alongside the tractor tracks are handy for unloading.

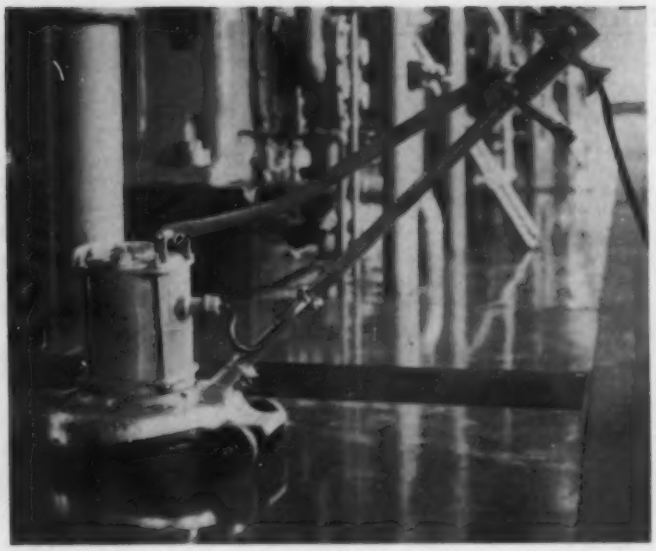
Put Chains on More Safely, Easily with Angle Iron Device



Here is an idea that will save time, effort and reduce the chance of accidents when putting chains on trucks. Attach a small chain with lap link and hook on each end to a piece of angle iron just long enough to span the tread surface of dual tires. Lay the angle iron against the tires and fasten hooks over the lip of the rim as shown.

Then spread mud chains out straight ahead of the wheels, fasten the rear end of the chains to the angle iron and roll the truck onto them. When the truck is rolled through about three-fourths of a revolution, unhook the angle iron and fasten the ends of the chains together.





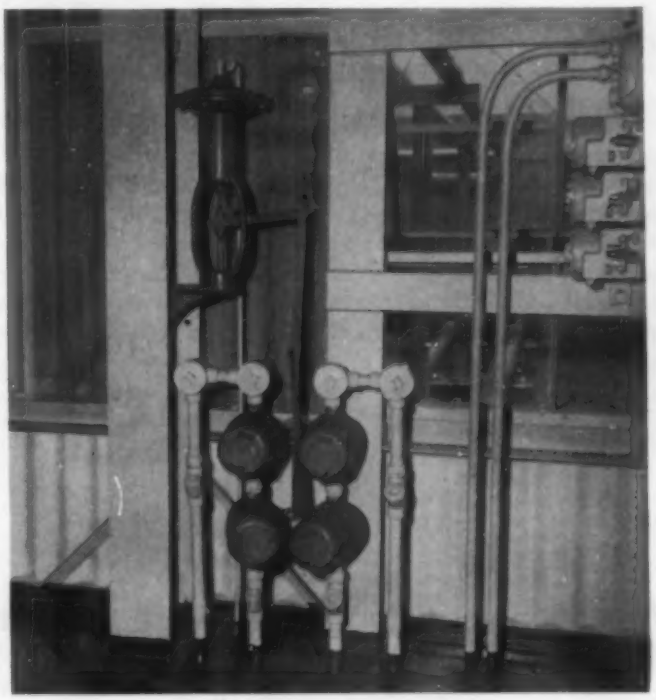
Extra Handle Makes It Easy to Carry Floor Polisher

An extra handle on a floor polisher makes it easy for two men to carry it about the station. When the extra handle is not in use it folds out of the way, but when the polisher is moved upstairs or downstairs, it is hooked to the top of the motor case as shown at left.

Note, too, the special bell-shaped fitting at the point where the cable goes into the handle; it will prevent wear on the cable and shorts.

This Convenient Rack Aids Building Up Piston Ring Grooves

Here is a rack which makes it easier to add weld metal to piston ring grooves. Since the heat from continuous welding would distort the piston, the welding must be done in short spurts. With the rack shown, the welder can work three pistons at a time. Each of the circular tubs turns on ball bearings, making it convenient for the welder.



Air Pressure Cuts Engine Ignition in Emergencies

Exhausting the air pressure from the control valve shown will cut the ignition to all engines in a compressor building, instantly. When the pressure is released, the control valve stem rises and the linkage opens the switches in the explosion-proof circuits. This system is connected with the general emergency shutdown controls.

Groove-Type Fittings Prove Economical

An investigation by engineers into the costs of joining pipe shows that groove-type fittings and couplings may give worthwhile savings in original installation, maintenance and down-time.

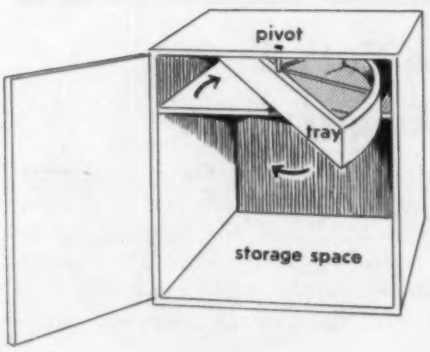
Perhaps the big advantage of the groove-type fittings over thread type is the ease of installation. Only a light wrench is used, no back-up tools are required, less labor is expended, chances of accidents in hazardous areas are reduced, and they can be installed in from one-fifth to two-thirds time taken for threaded connections.

Maintenance costs are lower, too. There are less problems of line-up. Limited end play allows for shock, ground motion, end pull, vibration and contraction and expansion.

Grooving is quicker than threading and less metal is removed from the pipe. There is little or no wear on fittings so they may be re-used. Temporary lines may be easily reclaimed and relaid. Much of the practice with these fittings developed from their use by the military for temporary fuel lines.

Recent development of cheaper, lightweight couplings has reduced the initial cost of the fittings. It is still above screw fittings, but other advantages make use of groove-type fittings worthy of economic consideration, now.

Make a Rotating Tray Kit for Small Tools



An easily fabricated kit for a welding or maintenance truck will save time and hunting for small tools. The box and tray can be quickly welded together from scrap sheet.

The semi-circular tray is pivoted as shown so that when the kit door is open the tray may be rotated outside the kit. Tools and fittings can be reached easily without a lot of hunting. This kit, made by a welder for use on a welding truck, could be handy on many pipe line jobs.

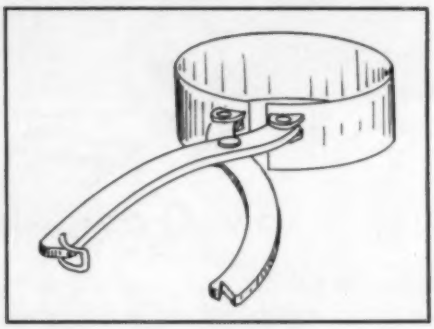
Three Items Streamline Maintenance Warehousing

Three items, a tag, a box and a catalog, can streamline the issuing of material for any station maintenance warehouse. First, every item in the warehouse is tagged with a stock number and catalog number. When an item is issued, the tag is removed from the material and dropped into the box as shown at the left.

When the tags are collected, the numbers are checked and entered on a recurring requisition which is, in this case, sent into the company office when the number of specialized items on the requisition falls below a certain level. Then the material is re-

ordered and the requisition returned to the field.

Every item stocked in the warehouse is listed in the catalog.



Power Cylinder Ring Clamp Simplifies Engine Overhaul

One of the problems following up engine overhaul is reinstalling the new rings and pistons in the power cylinders. The clamp shown is designed to handle the ring and make this job simple. Generally, this tool is used above the standard ring compressor which is supplied by manufacturers.

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The unusual installation above shows two 10-inch ASA 900 lb. Commercial Type "DPL" Orifice Fittings on a major oil company's offshore platform in the Gulf of Mexico.

The measurement platform, in construction above but now in service, was added to the original drilling and gathering system platform. The offshore unit consists of crew's quarters, drilling, gathering and measurement platforms, and is located 21 miles from shore in 20 to 25 feet of water.

The system strips and measures the gas through the two 10-inch orifice meter tubes. The gas and liquid are recombined, discharged into a 20-inch pipeline to shore, and again stripped and measured prior to distribution.

Meters are read daily and charts are maintained by the crew, which lives on the platform. Due to the large gas volume measured, meters and orifice fittings are given routine tests *twice* a month.

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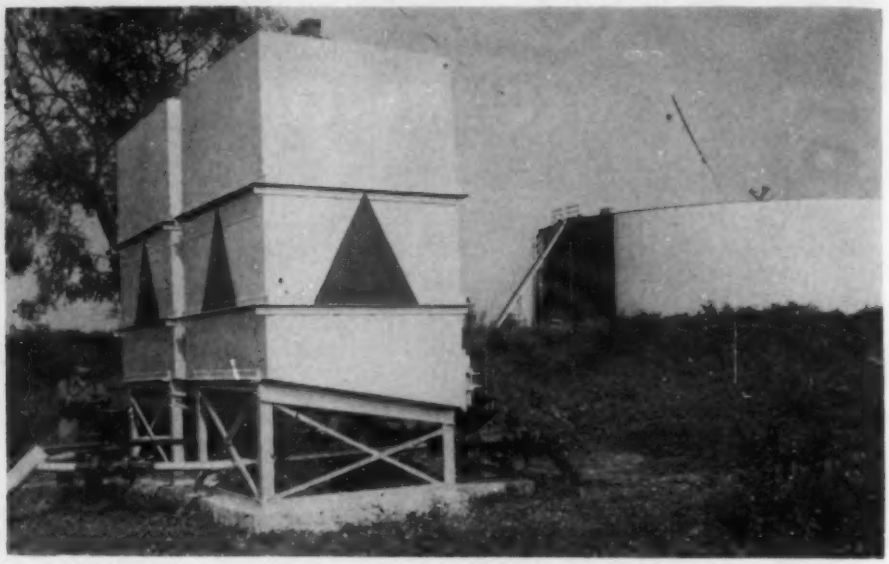

Storage, Mixing Unit Aids Fire Fighters

Here is a storage and mixing facility which aids fire fighters. Chemicals in powder form which when mixed with water form a "foaming" type fire-extinguishing fluid are stored in the tanks shown. High pressure water lines run underneath these vessels. At the lower right side of the storage tanks can be seen the hoppers and below them the water jets.

In operation the doors above the hoppers are opened allowing the powder to flow into the hoppers where the high pressure water jets pick it up. The mixture is then forced directly into the tank in which the fire occurs.

Use Dish Pan as Reflector For Ditching Machine Light

By cutting a hole in a dish pan and mounting a light globe in it, one pipe line contractor provided an effective night light for his ditching machine. The light and reflector were attached to a board mounted on the front of the machine.

Earthen Unloading Ramp Is Easy to Build, Useful

When necessary to haul off dirty oil and various skid mounted tanks, etc., from compressor and pump stations, build an earthen ramp to facilitate unloading the pick-up or bobtail trucks. Make the ramp, as shown above, by driving timbers in the ground. Line them with creosoted planks to form an open box the height of the truck bed. Use a bulldozer to fill the box with dirt.

To unload, simply drive the truck down in front of the box, back up to it and skid the material onto the ground.

Tuffy® SLING NEWS

Vol. 1 — Published Monthly in Leading American Trade Magazines by Union Wire Rope Corp. — No. 1

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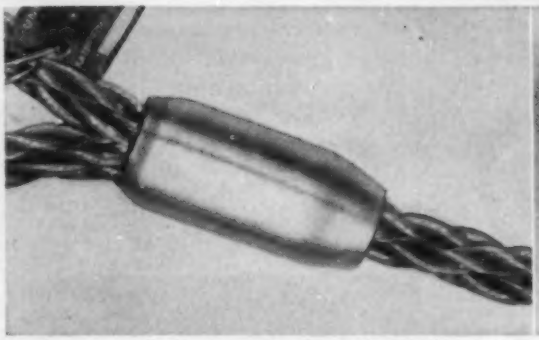
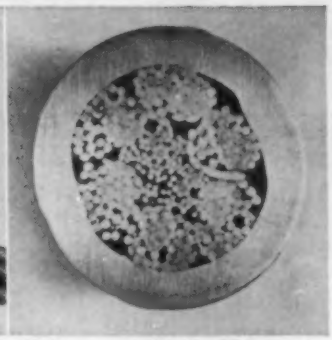


A heavy walled, streamlined steel ferrule is pressed on over tucked eye splice of Tuffy machine braided wire fabric from which sling is made.



Under exceedingly great pressure, the metal of the ferrule is flowed into fabric interstices.

Tuffy Makes Sling History Again With New Ferrule

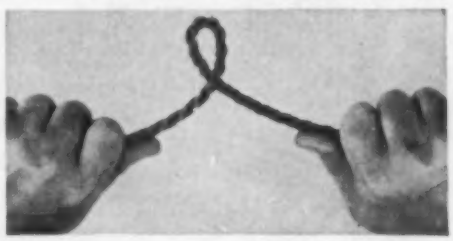
Tuffy Slings upset sling history quickly when introduced. The patented machine braided Tuffy Sling fabric has been upsetting sales and service records ever since.

Now, Tuffy Slings are making history again with a streamlined metal ferrule squeezed on over tucked eye splices so tightly that the eye splice has strength equal to that of the machine braided wire fabric. It makes Tuffy Slings stronger and safer. The ends of the tapered ferrule are swaged tightly to the fabric leaving no edges to hang up on loads or to injure workers' hands in hitching to and unhitching from loads. This, coupled with the great flexibility of Tuffy machine braided sling fabric, makes Tuffy Slings the handler's favorite.

High Strength of Famous Tuffy Machine Braided Flexible Wire Fabric Equalled in Eye Splice

Tuffy Slings' unusual resistance to kinking and the ease with which kinks are straightened out without damage to strands has piled up sling savings through longer service life.

Now, more advantages, bigger values are added to Tuffy Slings. Eye splices are made as strong as sling fabric with steel ferrule pressed on under great pressure over eye splice tucks. It's streamlined with ends tapered smoothly to fabric for safer, easier, faster hitching and unhitching on loads.



Your Tuffy Distributor Saves You Money!

Tell him what your future requirements might be. He'll keep a good stock for you to draw against. Call him soon. He's the man who can supply the biggest value in Tuffy Slings and Tuffy Hoist Lines to team up with your Tuffy Slings.

New Edition of Tuffy Sling Handbook FREE — Mail Coupon Now

This new 60-page Sling Handbook is a completely revised edition of the famous Tuffy book that first made sling news several years ago. The new edition shows you why Tuffy's new tuck splice and pressed-on ferrule can speed up sling-loading work, improve safety records. It contains complete information about a full line of factory-fitted Tuffy Slings, nearly a dozen new standard fittings available, and complete data and charts on all Tuffy Slings. It also has a brand new engineer's notebook and a valuable rigger's manual.

Get FREE Sling Handbook Mail Coupon Today

We just want you to see what a difference the new Tuffy ferrule and tucked splice make. We want you to have the advantages of this big, fully illustrated and charted sling guide. No obligation. Write now.

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Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand.

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12

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Tough — wears like iron, takes endless snagging, scraping, chafing and still gives full protection.
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Waterproof — made with top quality base fabric, first saturation-coated, then coated on the inside as well as on the outside with specially blended Neoprene Latex.

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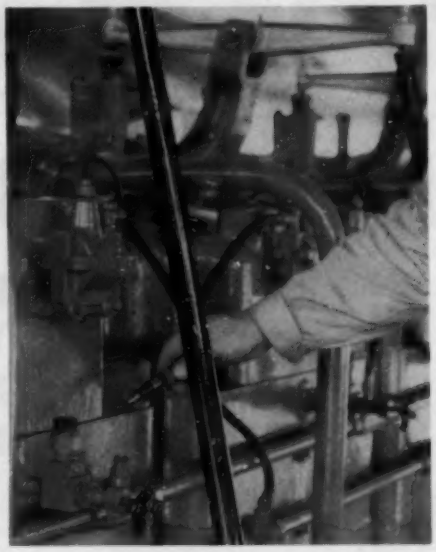
HINTS . . .



Simple Electrical Fitting Speeds Engine Overhaul

One of the complicated jobs which has in the past been associated with overhaul of an engine is disconnecting the ignition wires from a cylinder head prior to removing the cylinder head from the engine.

With this wiring ordinarily inside the conduit, the conduit had to be disconnected first, then the wiring, and so on.

One company simplified the entire job by making it possible for a man to disconnect the ignition to an entire engine in just a few minutes time. The fittings and flexible conduit were run from the coils to the rigid conduit on the side and it was so arranged that by simply backing off one nut, each ignition wire could be disconnected.

Such an arrangement is permitted by the safety code on engine wiring.

Build Handy Wall Cabinet For Maintenance Tools

A wall cabinet provides an excellent place to store caps, dyes, etc., for any pump station or compressor building. Needing to be only six inches deep, the cabinet can be hung in any unused wall space. When the door is closed, it takes up little room in the warehouse.

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water cans and coolers

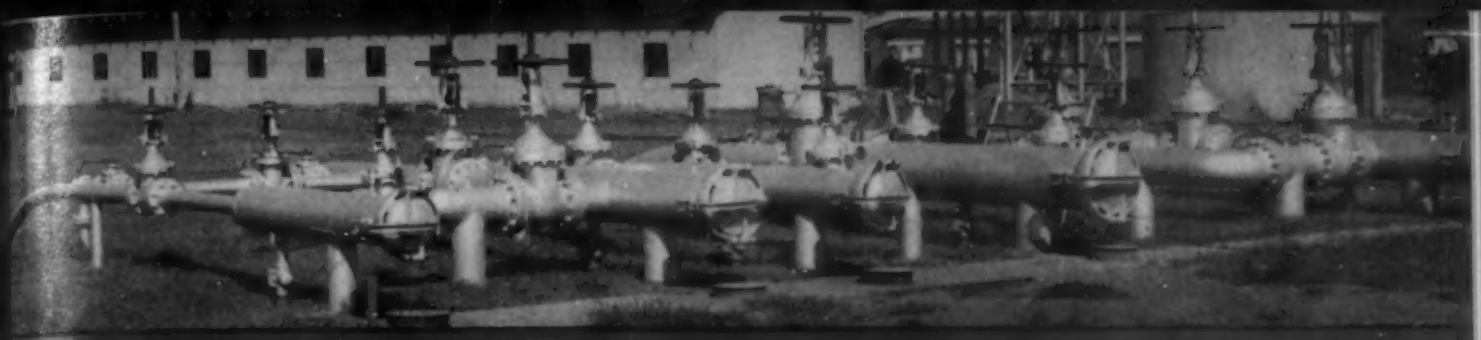
Specify **"GOTKOOL"** the next time you order water cans or coolers. **"GOTKOOL'S"** exclusive construction keeps water cooler . . . fresher . . . purer. Extra wide, snug-fitting, splash-proof top keeps out impurities. Non-leaking, push-button faucets, either extended or recessed flush mounted. *Buy* **"GOTKOOL"** *at your supply store today.*

GOTKOOL Water Cooler — made in 2, 3, 5, 8, 10, 15, and 20-gallon sizes with extended or recessed flush-mounted faucet optional. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

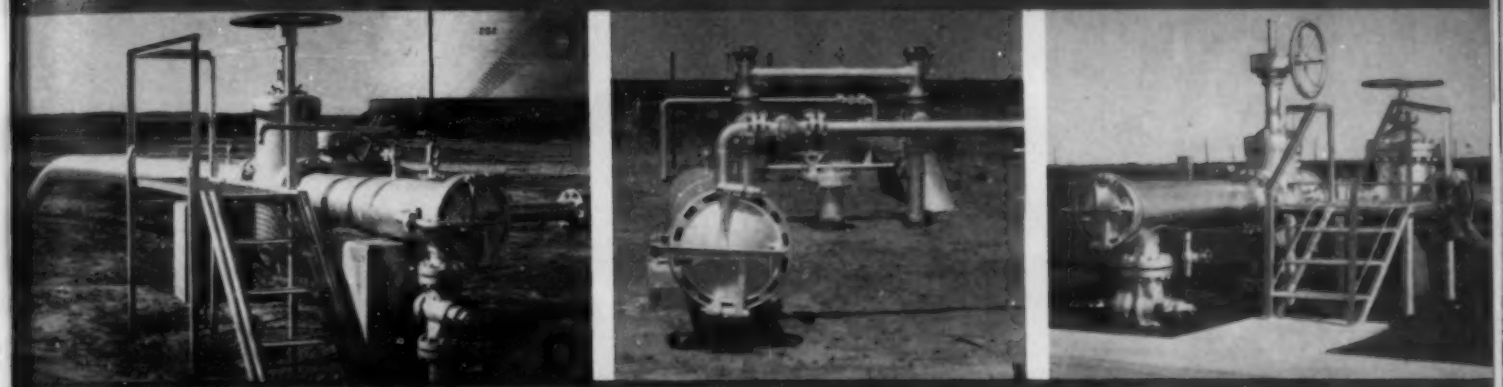
GOTKOOL Water Can — made in 1½, 2, 3, 5, 10, and 20-gallon sizes without faucets. Extended or recessed flush-mounted faucets available at slight additional cost. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

Insist on the genuine — look for the Blue and Black Label with the name "GOTKOOL" in Red.

H. P. GOTT MFG. COMPANY
WINFIELD, KANSAS



The handiest, safest way to



start and catch a pig....

Unibolt Hinged Scraper Traps

All you need do to open the UNIBOLT Hinged Scraper Trap is release two bolts and the blanking plug swings open like a door. No heavy lifting. Nothing to fall on workmen. No time-consuming blind flanges to make up. No danger of leaks—the UNIBOLT self-sealing oil-resistant gasket, which seldom needs replacement, assures a pressure-tight seal and low maintenance.

Many operators fabricate UNIBOLT Hinged Scraper Trap closures on an oversize barrel in order to facilitate starting the pig. Thus, line pressure does the heavy work.

Wherever multi-bolt flanged couplings and closures are now being used . . . on strainers, scrubbers, mist removers, terminal manifolds, blowdowns or other pressure vessels . . . UNIBOLT Couplings will serve you better.

THORNHILL CRAVER CO.

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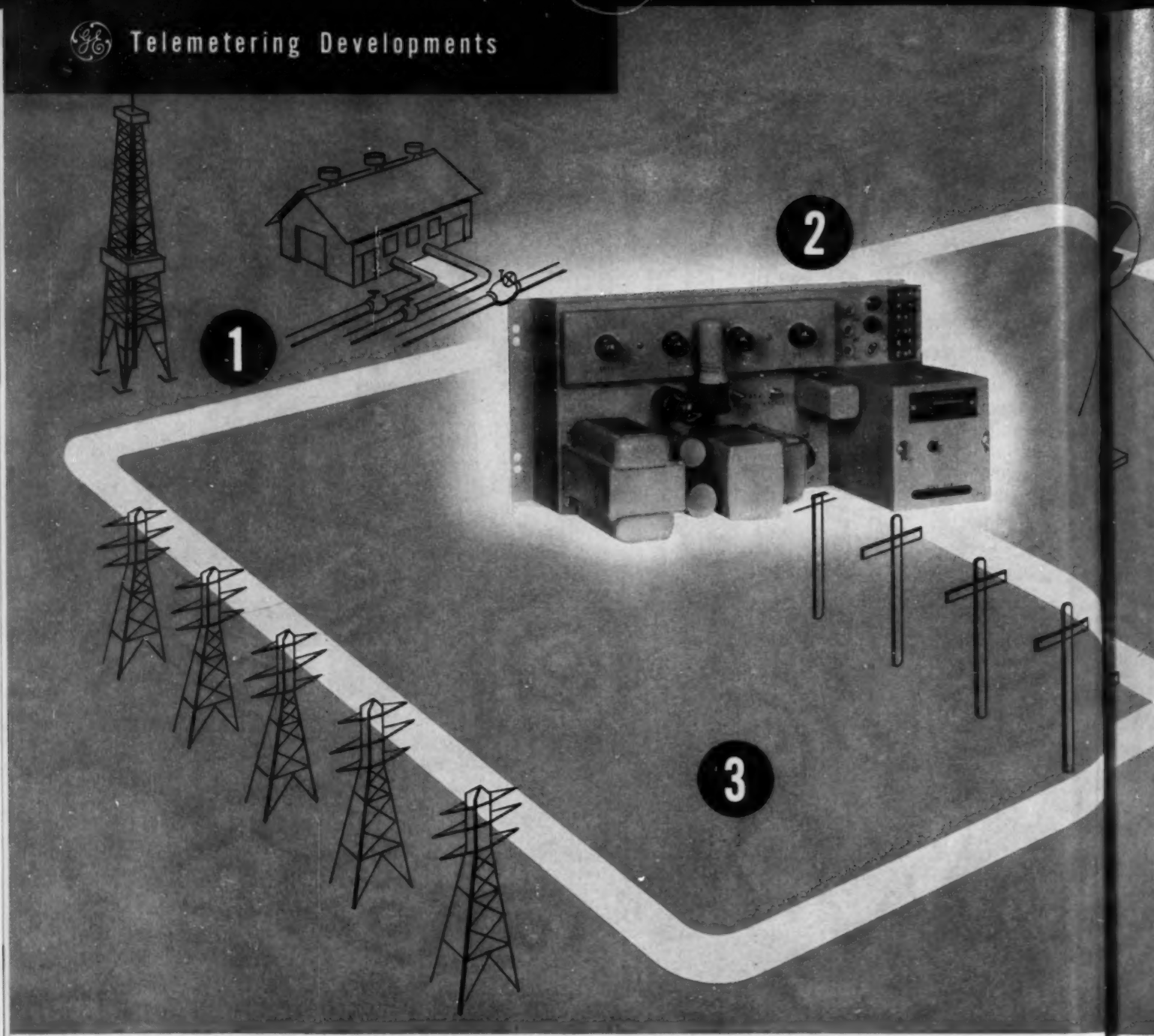
Telemetering Developments



1 **PIPE-LINE PUMPING STATION** pressures are typical quantities telemetered by General Electric equipment for indicating, recording, totalizing, or control at a remote point.

2 **TELEMETER TRANSMITTER** receives the transducer signal, converts it to a proportional frequency, and transmits it almost instantaneously with an accuracy of ±1% full scale.

NEW G-E Telemeter Transmitter

General Electric's new d-c input, frequency-type telemeter can be used with any d-c output primary detector to telemeter such quantities as pressure, flow, temperature, or other quantities important to the pipe-line industry.

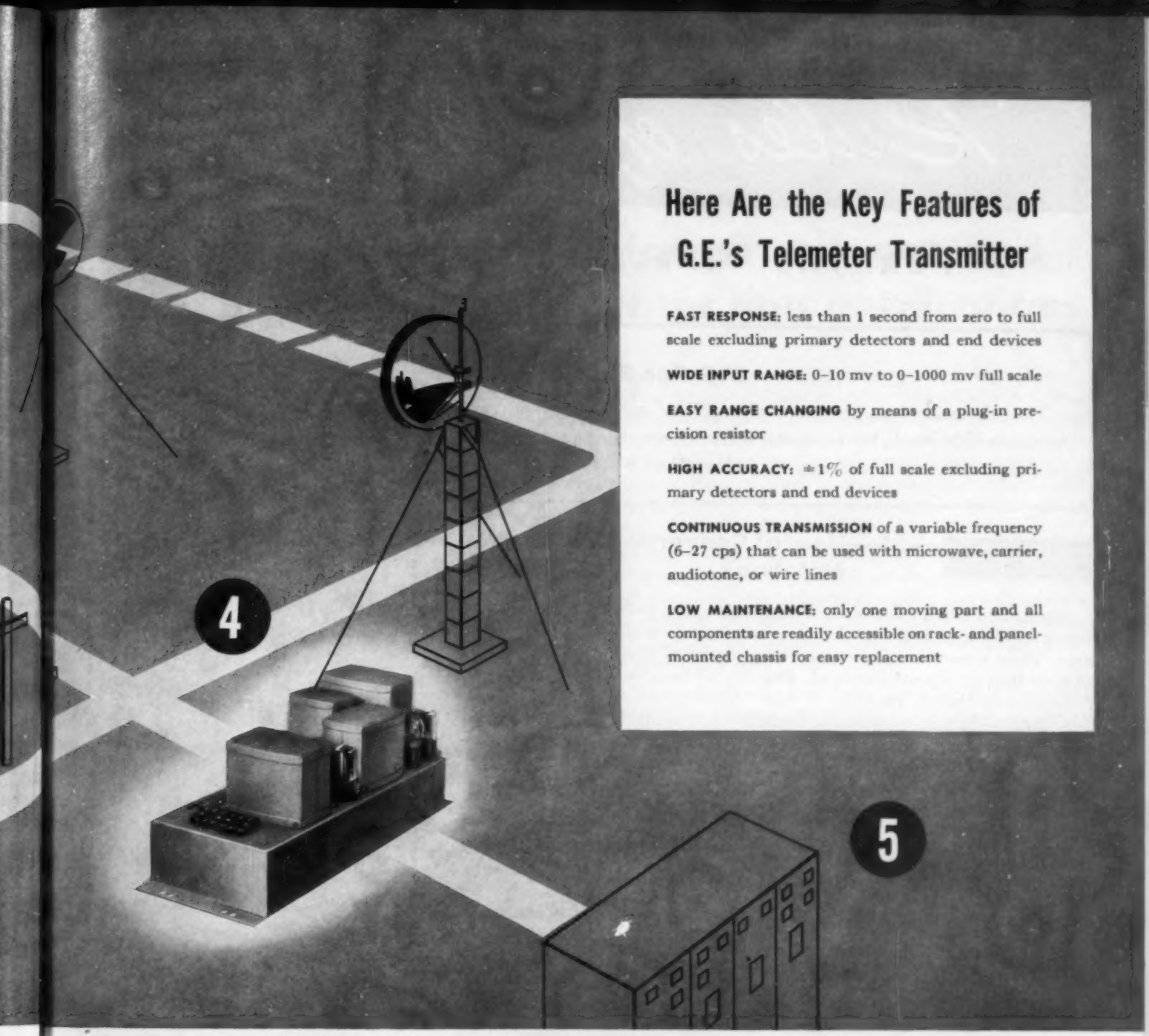
IDEAL FOR CONTINUOUS READING OR CONTROL, this new addition to G.E.'s line of telemetering equipment transmits a continuous signal that combines high accuracy with fast response.

USABLE WITH ANY TYPE CHANNEL EQUIPMENT, the new Type TF-8 transmitter can be applied economically for either short or long distances.

COSTS ARE REDUCED because the TF-8 transmitter can be

Progress Is Our Most Important Product

GENERAL ELECTRIC



Here Are the Key Features of G.E.'s Telemeter Transmitter

FAST RESPONSE: less than 1 second from zero to full scale excluding primary detectors and end devices

WIDE INPUT RANGE: 0–10 mv to 0–1000 mv full scale

EASY RANGE CHANGING by means of a plug-in precision resistor

HIGH ACCURACY: ±1% of full scale excluding primary detectors and end devices

CONTINUOUS TRANSMISSION of a variable frequency (6–27 cps) that can be used with microwave, carrier, audiotone, or wire lines

LOW MAINTENANCE: only one moving part and all components are readily accessible on rack- and panel-mounted chassis for easy replacement

3 **CHANNELS** used with G-E telemeters may be either power-line carrier, wire lines or microwave.

4 **TELEMETER RECEIVER** converts frequency signal to a proportional d-c milliampere or millivolt output.

5 **END DEVICE** may be an indicating or recording d-c milliammeter or millivoltmeter (potentiometric type).

Gives Fast Response, 1% Accuracy

paralleled with existing potentiometric recorders eliminating the need of an additional primary detector for telemetering.

BUILT-IN TEST FACILITIES are provided by the new G-E transmitter so that the operation of channel equipment as well as the telemeter receiver and end device can be easily checked.

FOR MORE INFORMATION or application assistance, contact your nearest General Electric Apparatus Sales Office or mail the coupon.

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Please send me a copy of your new bulletin describing G.E.'s complete line of telemetering equipment, GEA-5233.

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Rules of Thumb

FOR THE PIPELINER'S NOTEBOOK

$15 Per Rule of Thumb

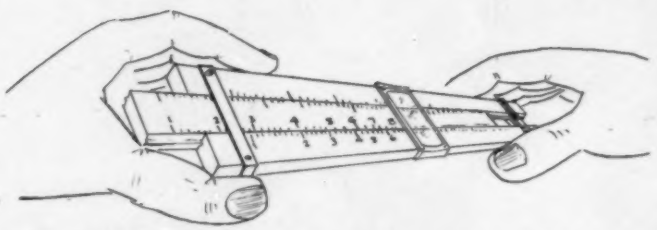
These formulae from the pages of engineers' own notebooks yield rough, but reasonably accurate answers for design, maintenance and supply questions. The Editors will pay $15 for your pet Rule of Thumb. Send your Rule of Thumb to PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1.

Miscellaneous

—25—Useful Conversion Factors for the Pipe Line Rule of Thumb Notebook

Often when a quick answer to a field engineering problem is required, an engineer's handbook may not be available. These conversion factors can be a handy addition to your Rule of Thumb Notebook. Others may be added from time to time as needed.

A therm—Energy demands are often expressed in terms of this unit, which is equivalent to 100,000 British Thermal Units (B.T.U.'s). An average heating value for natural gas is 1000 BTU per cubic foot; that for fuel oil is about 19,000 BTU per pound. Here are some other conversion factors.



Linear Measure

Centimeter	=	0.3937 inch
Chain	=	66.00 feet
Chain	=	4.00 rods
Foot	=	0.3048 meter
Inch	=	2.54 centimeters
Meter	=	3.281 feet
Meter	=	39.37 inches
Mile	=	5280 feet
Mile	=	1.609 kilometers
Rod	=	16.5 feet
Yard	=	0.9144 meter

Area Units

Acre	=	43,560 square feet
Acre	=	4,047 square meters
Acre	=	160 square rods
Square centimeter	=	0.1550 square inch
Square foot	=	0.0929 square meter
Square inch	=	6.452 square centimeters
Square kilometer	=	0.3861 square mile
Square meter	=	10.76 square feet
Square mile	=	2.590 square kilometers

Cubic measure (Volume)

Barrel	=	5.6146 cubic feet
Barrel	=	42.0 gallons
Cubic centimeter	=	0.06102 cubic inch
Cubic foot	=	0.1781 barrel
Cubic foot	=	7.4805 gallons (U.S.)
Cubic foot	=	0.02832 cubic meter
Cubic inch	=	16.387 cubic centimeters
Cubic meter	=	6.2897 barrels
Cubic meter	=	35.314 cubic feet
Cubic meter	=	1.308 cubic yards
Cubic yard	=	4.8089 barrels
Cubic yard	=	46,656 cubic inches
Cubic yard	=	0.7646 cubic meter
Gallon (U.S.)	=	0.02381 barrel
Gallon (U.S.)	=	0.1337 cubic feet
Gallon (U.S.)	=	231.0 cubic inches
Gallon (U.S.)	=	3.785 liters
Gallon (U.S.)	=	0.8327 gallon (Imperial)
Liter	=	0.2642 gallon
Liter	=	1.0567 quarts
Quart (liquid)	=	0.946 liter

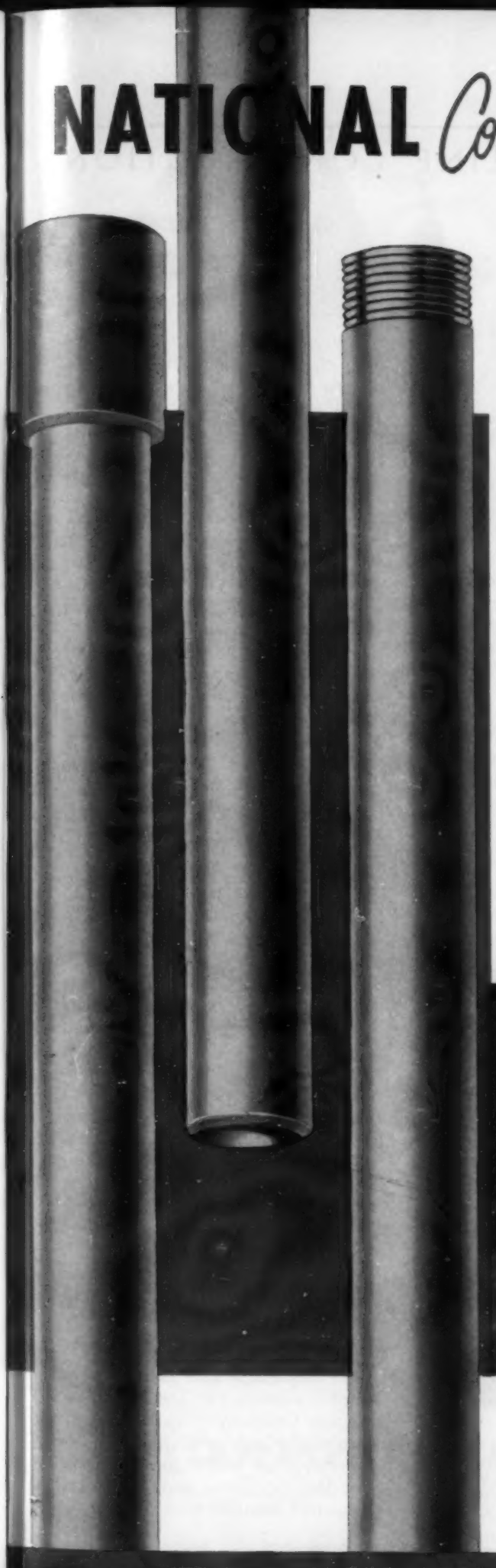
Weight

Grain (Avoirdupois)	=	0.06480 gram
Gram	=	15.432 grains
Gram	=	0.03527 ounce
Kilogram	=	2.2046 pounds
Ounce (Avoirdupois)	=	437.5 grains
Ounce (Avoirdupois)	=	28.3495 grams
Pound	=	0.4536 kilogram
Ton (long)	=	2,240 pounds
Ton (metric)	=	2,205 pounds
Ton (short)	=	2,000 pounds

ACKNOWLEDGMENT

Conversion factors taken from the "Practical Petroleum Engineer's Handbook," by Joseph Zaba and W. T. Doherty, Third Edition, pages 28-29. Gulf Publishing Company (1951).

NATIONAL *Continuous Weld* LINE PIPE



for air, oil, gas and water line applications

The superiority of NATIONAL Continuous-Weld Line Pipe pays off for you in easier installation, better performance and longer service life. This superiority is based on three important factors. First . . . Over 60 years of experience in making tubular products famous for their high quality. Second, the most modern butt-weld pipe-making facilities in the world at Fairless Works, Fairless, Pa. And, third, the use of the unique stretch-reduction process, employed by National Tube since 1942.

Combined they give you a butt-welded line pipe that is always completely uniform throughout—in metallic structure, ductility, strength, corrosion resistance, surface finish and wall thickness. The working of the metal in the exclusive stretch-reduction process, itself, gives NATIONAL Continuous-Weld Line Pipe a better weld and a higher safety factor.

Get NATIONAL Continuous-Weld Line Pipe. It is available in sizes ½-inch to 4 inches. It's your best buy for air, oil, gas and water line installation.

For further information, write National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
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USS

NATIONAL *Continuous Weld* LINE PIPE

UNITED STATES STEEL

Tennessee Gas-Midwestern Gas Put Canadian Gas Plan Before FPC

By **MELVIN A. JUDAH,** PIPE LINE INDUSTRY Staff

In companion applications filed with the FPC, Tennessee Gas Transmission Company, and a new associated firm, Midwestern Gas Transmission Company, ask for authority to construct facilities to serve new midwestern areas and to take and deliver Canadian gas. TGT also seeks permission to add facilities along its system to meet increased demands of present customers.

Midwestern would construct a 1112-mile line from near Emerson, Manitoba, to Nashville, Tenn., at an estimated cost of $98 million. This proposed line would serve market areas in Minnesota, Wisconsin, western Michigan and eastern North Dakota. Under terms of a contract signed recently with Trans-Canada Pipe Lines, Ltd., Midwestern would import 200,000,000 cubic feet of gas daily from Canada with the possibility of an additional 200,000,000 cubic feet when and if available.

Delivery capacity of the Midwestern line would be 400 million cubic feet per day. In addition to the main line, 648 miles of main line extensions of from 18 to 3 inches in diameter are planned. Compressor stations are to be located near Portland, Tenn., Paris, Ill., Sharon, Wisc., Brainerd, Minn., and Noyes, Minn.

TGT filed three applications; two involved system expansions amounting to nearly $43 million and one requesting authority to export gas to Trans-Canada at Niagara Falls on a short term basis. Proposed expansions would boost TGT's system capacity to approximately 2 billion cubic feet daily and 2.5 billion feet for peak days.

In one request, TGT seeks to build $18.6 million in facilities in order to deliver 200 million cubic feet per day to Midwestern near Nashville. Included would be five new compressor stations in Texas, Louisiana, Mississippi and Tennessee; additions to four existing stations, and 100 miles of gathering lines in Texas and Louisiana.

A second proposal asks a $24.3 million system expansion to meet expanding needs of TGT's present customers by an addition of 108,978,000 cubic feet per day delivery capacity.

This would require construction of 162 miles of loop lines in Kentucky, Ohio and Pennsylvania; two new compressor stations in Tennessee and Massachusetts, and enlargements at four other stations.

Tennessee Gas also applied for authority to deliver up to 86,755,000 cubic feet per day to Trans-Canada at the international boundary near Niagara Falls on a short term basis. This gas would be used to serve and develop markets in the area between Toronto and Montreal prior to completion of Trans-Canada's all-Canadian pipe line. Trans-Canada now has a line from near Niagara Falls to Toronto which serves that area, and has been authorized by the Canadian government to build an extension to Montreal. Financing has been arranged and contracts signed for sales to Quebec Natural Gas Corporation.

Construction on the TGT-Midwestern projects would be started as soon as FPC authorization is granted. Present estimates call for completion and start of service by November 1, 1956.

Work Moves Ahead on Bolivian Pipe Line

Here right-of-way clearing begins in the rugged country along the Cochabamba-Oruro-LaPaz route. Williams Brothers has the contract to build the 230-mile 6-inch products line for Yacimientos Petroliferos Fiscales Bolivianos. Cost of the line is estimated at $7 million. Bolivian Government plans call for future construction of a 10-inch products line from Oruro, Bolivia, to Arica, Chile.

Ted Price to Build Line For Texas Pipe Line Company

The Texas Pipe Line Company has awarded a contract to Ted Price Construction Company to construct 27 miles of 8⅝-inch crude pipe line between its Kings Mill Pump Station in Gray County, Texas, and The Texas Company's Amarillo works.

CAN YOUR BUILDINGS PASS THIS FIRE TEST?

AFTER THE FIRE... A NEW PAINT JOB, AND READY FOR BUSINESS AGAIN.

Here's a typical example of how Armco Steel Buildings reduce the threat of fire damage. A rubber tire-fed fire raged inside this 24-foot-wide building for a half hour, destroying much of the contents. Yet the owner was able to put the structure back in service without replacing any building parts. New window glass and paint did the job.

Fire-resistance is just one advantage you can have in an Armco Building. Interlocking STEELOX Panel construction saves erection time and money; provides a sturdy, weather-tight building. You save framing, rafters, sheathing and roofing because the panels provide both structural support and finished exterior. Workmen need no special training to do a fast, efficient erection job.

The wide range of standard sizes makes it easy to meet your specific space needs. Floor areas are practically unlimited—from 20 square feet up! Whether your building problems include office, warehouse, meter station, pump house or other facilities, Armco Steel Buildings may be your most economical, permanent solution. Write for details. Armco Drainage & Metal Products, Inc., 5315 Curtis St., Middletown, Ohio. Subsidiary of Armco Steel Corporation. Export: The Armco International Corp.

ARMCO STEEL BUILDINGS

American Louisiana Begins Air Testing of Detroit Line

As construction crews move southward along American Louisiana Pipe Line Company's 30-inch line this fall, testing crews will follow closely using custom-built high pressure air testing equipment. Diesel driven compressor units were designed and assembled on trailer mounts especially for this job. Speed and mobility will be added to the safety advantage of high pressure air for pipe line testing.

This low-stage unit consists of two diesel driven compressors which compress air from atmospheric up to 150 pounds per square inch and discharge in the suction side of a single high-pressure diesel driven compressor mounted on another trailer. A field header is being fabricated in the foreground.

Test units are made up of three diesel engines driving two low-stage compressors and one high-stage compressor. The two low-stage units are mounted on one trailer and the companion high pressure unit on another. Low-stage compressors develop 150 pounds per square inch and discharge directly into the high-stage unit which is capable of pressures up to 1000 pounds.

As on all pipe line spreads, time is important in testing the line after construction is complete so testing crews operate around the clock. Six men are needed to operate each field testing section, working in eight hour shifts of two men per shift.

Actual tests consist of bringing the line up to a pressure of 944 psi—a minimum of 10 percent above maximum operating pressure. Pressure is then held for a 24-hour period, during which it is checked by a dead weight tester on recording pressure gages.

To make efficient use of compressor facilities, high pressure air is then bled into the next section down the line as soon as readings are completed on the section under test. Test sections vary from 5 to 15 miles in length on the American Louisiana line.

A 400-mile section of the Detroit to North Tepetate, La., line will be

16" and 20" HIGH-PRESSURE GAS LINES MODIFIED *in service*

COLORADO INTERSTATE GAS CO.

USES WmSON STOPPLE* TO FACILITATE INSTALLATION OF BLOCK VALVE ON THEIR 20" GAS TRANSMISSION LINE *WITHOUT INTERRUPTION OF GAS SERVICE TO THE CITY OF DENVER*

OPERATORS TURNING CRANK TO LOWER THE STOPPLE* SEALING ELEMENT INTO PIPELINE

MANUFACTURERS LIGHT AND HEAT COMPANY

OF PITTSBURGH, *CONTINUED GAS SERVICE* TO SEVERAL THOUSAND CUSTOMERS IN THE VICINITY OF WHEELING, WEST VA. WHILE INSTALLING A NEW PRESSURE REDUCING STATION ON THEIR 16" GAS TRANSMISSION LINE

*Patent Pending

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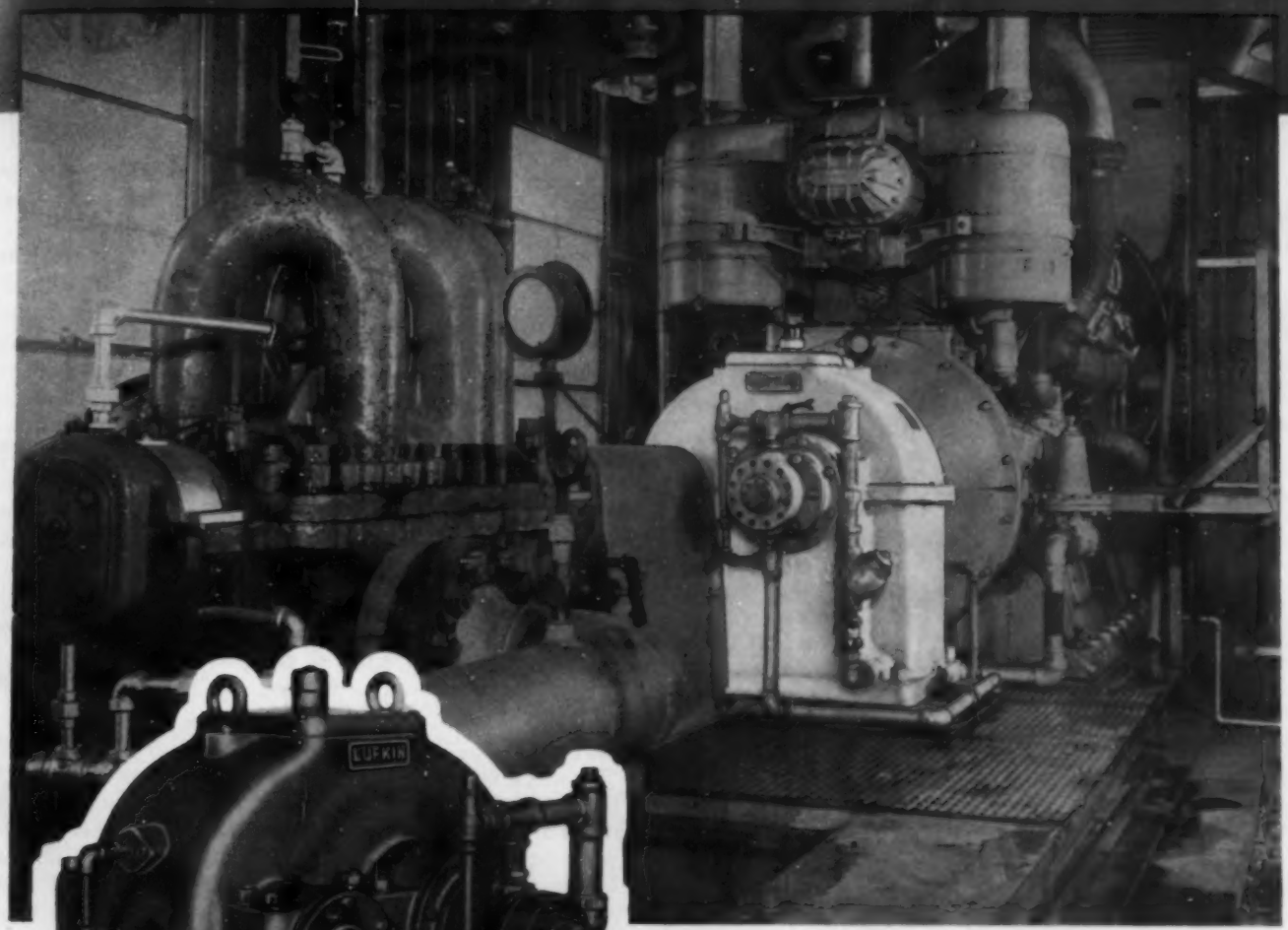
GUARANTEE THE UNINTERRUPTED TRANSMISSION OF POWER SO NECESSARY FOR THE UNINTERRUPTED TRANSMISSION OF OIL



HERRINGBONE GEARS GENERATED WITH EXTREME ACCURACY—RIGIDLY MOUNTED IN HEAVILY REINFORCED HOUSING—TO GIVE MANY YEARS OF QUIET, VIBRATIONLESS, TROUBLE-FREE OPERATION.

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Brookhaven, Mississippi • El Dorado, Arkansas

Lufkin equipment in Canada is handled by THE LUFKIN MACHINE CO. LTD. 14321 108th Avenue, EDMONTON, ALBERTA, CANADA

Testing has begun on the northern section of American Louisiana's 30-inch Detroit-Louisiana line. Shown here is the fleet of compressor units designed and built especially for high pressure air testing of pipe lines. Diesel driven units feature high capacities in the 900-1000 psi testing range and good mobility over right-of-way terrain.

air tested this fall. Crews starting at the Sales Station at Willow Run will work down to a point where the line connects with that of Texas Gas Transmission Corporation at Slaughters, Ky.

Central Kentucky Natural Plans to Build, Sell Facilities

The FPC has received an application from Central Kentucky Natural Gas Company seeking authority to construct natural gas facilities costing an estimated $2,474,100. Central also asks to abandon a compressor unit at its Menifee, Ky., station, and to sell some of its facilities to the Union Light, Heat and Power Company and to Cincinnati Gas and Electric Company.

If the application is approved, Central Kentucky would build 14.2 miles of 24-inch pipe line from Cold Springs to Anderson Ferry, Ky.; lay a dual 20-inch crossing of the Licking river on this line; and lay a dual crossing of the Ohio river at Anderson Ferry. Other new facilities include a 6.9-mile, 20-inch line from the Means compressor station to South Means, Ky., and addition of 1980-horsepower at the Means station.

A portion of the Menifee station would be retired, and nearly $50,400 worth of equipment utilized to supply the increase in horsepower at the Means station.

Central Kentucky would sell about ten miles of pipe line and portions of its multiple river crossings on the Licking and Ohio rivers to Union Light. Cincinnati Gas plans to purchase from Central Kentucky some facilities connecting with those being sold to Union Light.

Montana-Dakota Utilities Files Application With FPC

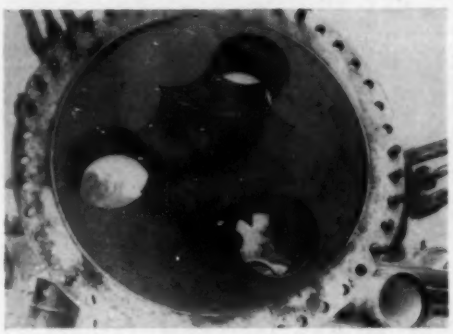
An estimated $1,428,000 of natural gas facilities is proposed in a recent application filed with the FPC by Montana-Dakota Utilities Company.

Proposed additions include a 41.8-mile, 12¾-inch transmission line, about two miles of branch transmission mains, two gas measurement stations, and gas distribution systems to serve the towns of Ray, Wheelock, Epping, and Springbrook, N. D.

The 41.8-mile line would tap a new gas supply in the Tioga-Beaver Lodge area and take residue gas from a plant operated by Signal Oil and Gas Company in Williams County.

TOPAZ cut nine coupons for this "hot" tap!

Tapping machine set up for cutting operation.



Star shaped center coupon, left after nine overlapping 12" cuts were made.

Engineers of TOPAZ and T. D. Williamson, Inc., working with Phillips Chemical Company, had the problem of tapping into Houston's industrial water supply line, (60 psi) without taking the line out of service.

The tap, needed for connecting a branch line, necessitated making a larger hole than any tapping machine could cut in one operation. It was decided to cut nine overlapping 12" coupons, making a 43" hole with a scalloped circumference.

A Model 1200 Williamson-Hillco tapping machine was used for the cutting operation. To reduce time and labor costs, three 12" gate valves were mounted on the adapter flange, allowing three cuts to be made before rotating the flange. Successful completion of this assignment serves as one example of the many ways in which TOPAZ serves the pipeline industry.

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GROVE SEAL "O" RING VALVES • TIPTON WELDING CLAMPS • WACHS-SAWS • ALSTON PIPE CUTTING MACHINES • FLEETLINE PIPE SADDLES & REDUCERS • H & M CUTTING & BEVELING MACHINES • ANDERSON EQUIPMENT CO. HEAVY MACHINES • ORDER FROM TOD PAZDRAL

When Line Pipe Wears A STRAIT-JACKET

Open section of Hydropress is shown only to illustrate operation. Length of pipe is completely encased during expansion.

THE "Strait Jacket" is an important step in the Youngstown process of producing high strength line pipe to API-5LX specifications. This "Strait Jacket" is actually a hydraulic expansion unit in which the pipe is expanded within a set of enclosed dies. In this operation the ends are sealed, water is forced into the pipe and pressure is increased to expand it evenly against the smooth steel walls of the expander.

This process proof tests and cold works the pipe simultaneously. As a result Youngstown Electric Weld Line Pipe with uniformly high strength, with uniform weld quality, with uniform straightness, with uniform wall thickness and with uniform diameter is ready for you.

* * * * * *

Five reasons why Youngstown Electric Weld Line Pipe is your best buy: (1) It bends readily; (2) Wall thickness is uniform; (3) Line up characteristics are excellent; (4) Weldability is outstanding; (5) Long lengths save you time and trouble. The Youngstown Sheet and Tube Company, Youngstown 1, Ohio. Sales and service offices throughout the oil and gas producing areas.

Youngstown

ELECTRIC WELD LINE PIPE

QUALITY YOUNGSTOWN SERVICE

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

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SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - BLACK PLATE - RAILROAD TRACK SPIKES - MINE ROOF BOLTS

Interprovincial Plans Loops In 1956 Building Program

Throughputs anticipated for 1957 will be in excess of the line capacity along sections of the Interprovincial Pipe Line Company, T. S. Johnston company president recently stated. To provide the needed capacity, the company announced plans for parallels to complete looping of the line between the Cromer, Manitoba, station and Clearbrook, Minn.

Proposed loops will be of 24 and 26-inch pipe. Approximately 69 miles will be laid in Canada and 51 miles in the U. S. Additional storage will be erected at Cromer and a 2040-horsepower pumping unit will be added to the station's existing equipment.

Pipe for the project will be furnished by a U. S. supplier as line pipe of this size is not now available in Canada. Cost of the project is an estimated $9 million. Construction will start in the spring and be completed before next winter.

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LIQUID GRAVITOMETER
For PIPELINES, REFINERIES, GASOLINE PLANTS
NOW 19 MODELS
MODEL R
This ruggedly built instrument of laboratory accuracy is ideal for quick checking and for continuous recording of Specific Gravity of liquids under line pressure. Changes in Specific Gravity of sample are recorded with a very minimum of time lag. Foreign liquids and gases are automatically purged from sample. No moving joints or stuffing boxes to cause friction or leakage. Temperature corrected, this precision instrument is adaptable to high pressures. Hundreds are in daily use in plants and refineries of major companies. Available in 19 Models for Recording, Signalling, Transmitting and Controlling. Send for Bulletin 111R-3.
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Trans-Canada Moves Ahead With Construction Plans

Developments are shaping up in the gigantic task Trans-Canada Pipe Lines, Ltd. faces in moving natural gas from the Western Canadian fields to choice markets in eastern Canada. Most recently, Trans-Canada has signed a contract with Canadian Gulf Oil Company for 170 million cubic feet per day for a 25-year term. Canadian Gulf, a subsidiary of Gulf Oil Corporation, is reportedly the first major supplier to enter into a long term contract with Trans-Canada. Gas will be delivered to Trans-Canada from the Pincher Creek field in southwestern Alberta.

Pending FPC approval of Tennessee Gas Transmission Company's construction proposal, Trans-Canada will deliver 200,000,000 cubic feet per day to a Tennessee Gas' associate, Midwestern Gas near Emerson, Manitoba. Trans-Canada would then plan to take 90 million cubic feet per day from TGT near Niagara Falls to develop eastern Canadian markets if the FPC approves. (See Tennessee Gas-Midwestern Gas construction story, this issue of PLI.) Pipe already has been ordered for the Toronto-Montreal line.

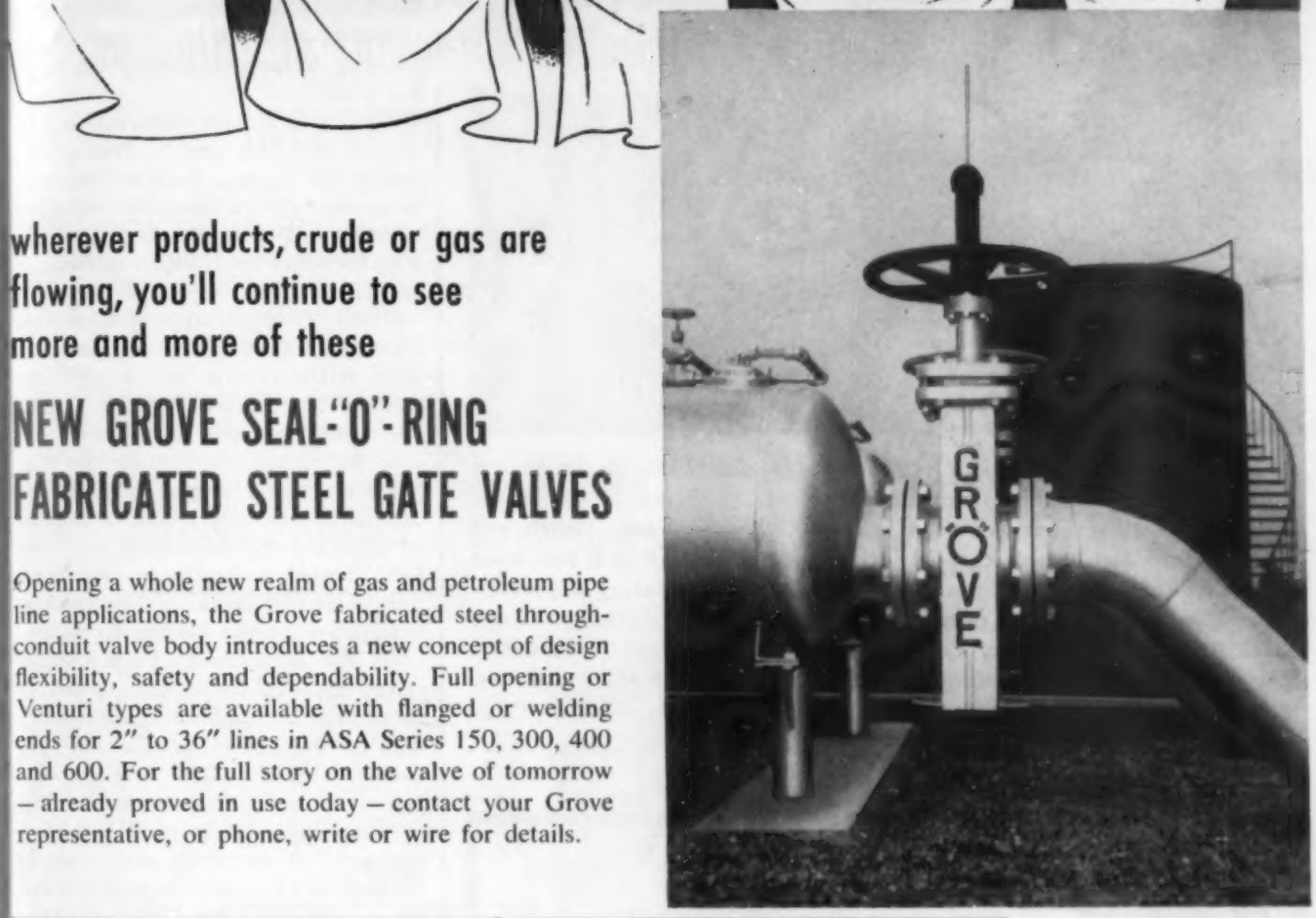
Soon after Trans-Canada received the approval of the Board of Transport Commissioners for the Toronto-Montreal section, orders were placed for the purchase of 335 miles of pipe. This quantity of 20 and 24-inch pipe, costing about $9 million, is scheduled for delivery by the beginning of the construction season in the spring of 1956.

There is still strong feeling in Canadian government circles for an all-Canadian line with some practical government assistance for the uneconomic link across northern Ontario. When Trans-Canada's main line from the Alberta-Saskatchewan border to eastern Canada is completed, Alberta natural gas will be used in the Toronto-Montreal line.

Texas Gas Acquires Assets of New Ulm

Acquisition by Texas Gas Corporation of the oil and gas producing properties and other assets of its subsidiary company, New Ulm Corporation, has been authorized. New Ulm's liabilities will be assumed by Texas Gas and the subsidiary company dissolved.

THERE'S SOMETHING NEW ON THE LINE



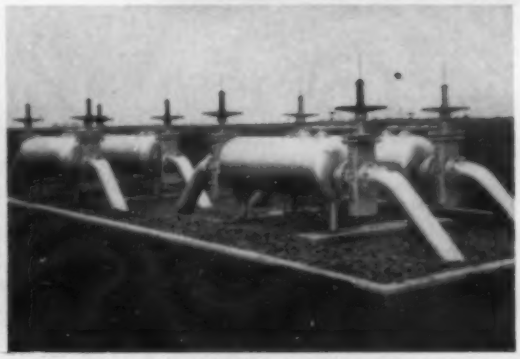
wherever products, crude or gas are flowing, you'll continue to see more and more of these

NEW GROVE SEAL-"O"-RING FABRICATED STEEL GATE VALVES

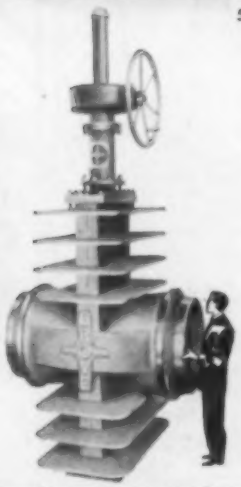
Opening a whole new realm of gas and petroleum pipe line applications, the Grove fabricated steel through-conduit valve body introduces a new concept of design flexibility, safety and dependability. Full opening or Venturi types are available with flanged or welding ends for 2" to 36" lines in ASA Series 150, 300, 400 and 600. For the full story on the valve of tomorrow – already proved in use today – contact your Grove representative, or phone, write or wire for details.

505

This is one of several carloads of new Grove Seal-"O"-Ring fabricated steel gate valves en route to a major gas pipeline.



Bubble-tight seal, with flow in either direction, plus freedom of operation of Grove Seal-"O"-Ring Valves is important on products line installations of this type.



GROVE SEAL-"O"-RING Gate Valves

GROVE VALVE and REGULATOR COMPANY • 65th & Hollis Sts., Oakland 8, California
HOUSTON 4 — 1901 Calumet St. • • • • • • • • **LOS ANGELES 6** — 1930 W. Olympic Blvd.

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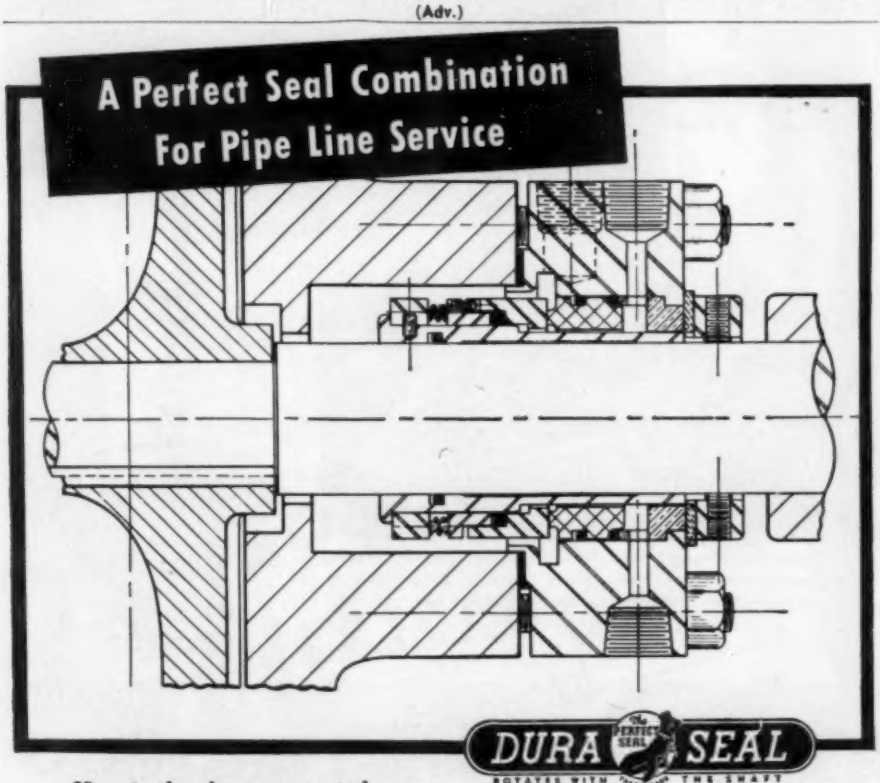
GROVE SEAL RING — GROVE — SIMPLICITY ACCURACY SAFETY

BACKFILLING 50 FEET PER MINUTE this Cleveland "190" Backfiller did a fast, clean, economical job on the recently completed Saskatchewan Power Company pipeline from Prince Albert to Coleville, Sask. Trench was 5½ feet deep and sloped from 20 inches wide at bottom to 6 feet wide at ground surface. The line is 219 miles long, not counting expansion loops. The unique one-man operation of the "190" saved many man-hours on this project for Majestic Contractors, Ltd., of Edmonton, Alberta. Your local distributor will show you how Clevelands do *more*—for *less*.
THE CLEVELAND TRENCHER CO., 20100 St. Clair Ave., Cleveland 17, Ohio
(Adv.)



Here is the sleeve-mounted mechanical seal "Package" assembly especially designed for multiple stage pumps on pipe line service. Easy to install from outer end of stuffing box . . . no special machining necessary

TYPE PTO

. . . no guesswork on setting the seals . . . no blind adjustments required. *Write for further details . . . mention Dura Seal Type PTO.*

DURAMETALLIC CORPORATION, *Kalamazoo, Michigan*

Panhandle Eastern-Trunkline Additions Approved by FPC

Recent action of the FPC gives Panhandle Eastern Pipe Line Company and its subsidiary, Trunkline Gas Company, temporary authority to construct facilities to increase deliveries by 15 percent during the coming winter.

Panhandle's main construction jobs are on the spur line to Peoria, Ill., and in Michigan to boost deliveries to Consumers Power Company and other customers. Improvements are scheduled for other lateral lines in Indiana and Illinois also.

The FPC approved temporary "operational improvements" on Panhandle's system which are being constructed to boost delivery by 80 million cubic feet per day. Crews can now begin construction on the 132 miles of lateral loops, estimated to cost $4,474,000 which will be needed to distribute the additional gas. The FPC denied authority for construction of 16,000 additional compressor horsepower on the Panhandle system.

At the same time, Trunkline received approval for facilities to deliver an additional 80 million cubic feet per day to Panhandle at Tuscola, Ill. Construction already is nearing completion on eight new compressor stations costing a total of $15 million plus line improvements amounting to $3,300,000. Trunkline's new stations are located in Texas, Louisiana, Mississippi, Tennessee and Illinois.

The joint Panhandle-Trunkline construction program will increase delivery capacity of the system from 1,070,000,000 cubic feet per day to 1,237,236,000 cubic feet per day on a temporary basis beginning December 1, extending through next March 31.

Wilcox Trend Proposes $2.9 Million Additions

The Wilcox Trend Gathering System, Inc., has filed with the FPC for authorization to build and operate new natural gas facilities totaling an estimated $2.9 million.

Construction plans include a 16-mile, 16-inch line looping Wilcox's present line to Provident City, Texas. At that point the line connects with Texas Eastern Transmission Corporation's facilities. In addition, Wilcox would lay about 5.5 miles of 3-inch line in the Jennie Bell and Gohlke fields; install an additional 2200-horsepower at its Thomaston station;

Smooth control

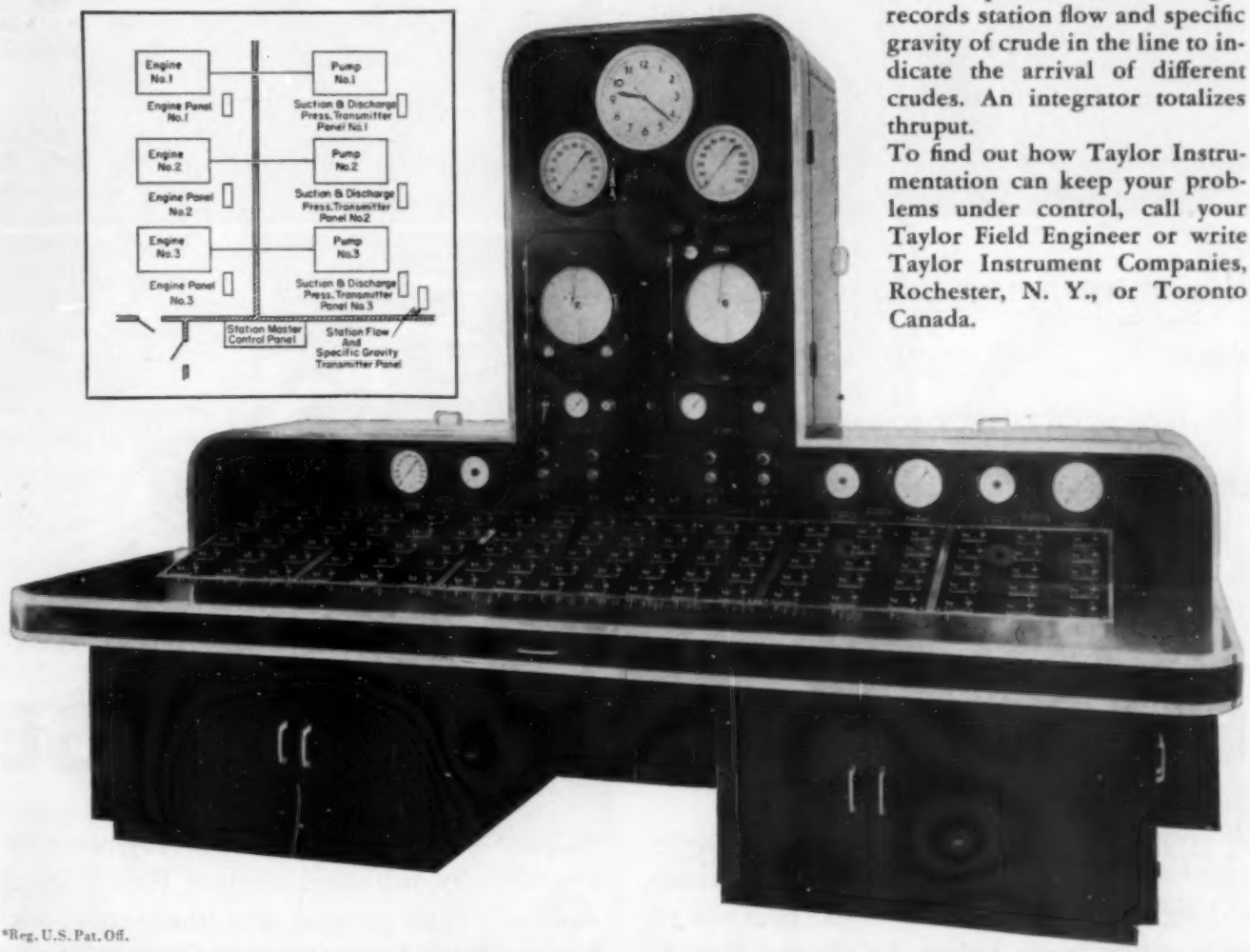
of shifts in thruput obtained by Taylor Instrumentation on INTERPROVINCIAL-LAKEHEAD PIPE LINE

STATION suction and discharge pressures are controlled and recorded automatically by the Taylor FULSCOPE* line of instruments on both sides of the border, and reports indicate that they are giving smooth control regardless of variations in thruput. There are several distinct advantages to this modern answer to the problem of pipeline pressure control:

1. The basic simplicity and dependability of these pneumatic controllers make them ideally fitted to the problems encountered in pipeline station pressure control.
2. FULSCOPE Controllers have proved themselves over the past 16 years.
3. They are easy to set up and adjust for optimum station performance.
4. Maintenance—what little is required—is extremely economical, since station pressure controllers and transmitters are the same basic instruments.

Pictured below is a Taylor control panel in a pumping station of The Lakehead Pipe Line Co., Inc. Gages in the center section (below clock) indicate station suction or discharge pressure. The FULSCOPE Controller at left is the master station control, arranged for suction or discharge pressure over-ride control, while the dual pen instrument at right records station flow and specific gravity of crude in the line to indicate the arrival of different crudes. An integrator totalizes thruput.

To find out how Taylor Instrumentation can keep your problems under control, call your Taylor Field Engineer or write Taylor Instrument Companies, Rochester, N. Y., or Toronto Canada.

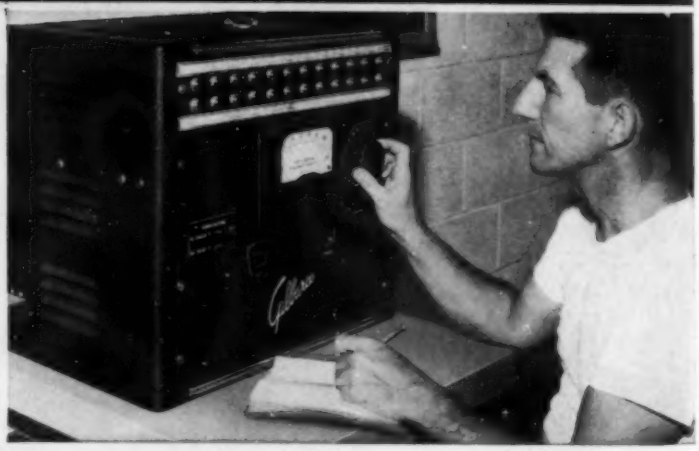


*Reg. U.S. Pat. Off.

Taylor Instruments MEAN ACCURACY FIRST

There's a faster, safer, cheaper, more accurate way to measure tanks with... a new

Gilbarco



ELECTRONIC TANK GAUGE

A crew of hand gaugers can climb slippery steel stairways in icy cold to lower tapes through opened manholes. Or one man can sit in a gauge house before a Gilbarco Remote Receiver and gauge tanks at the rate of fifty an hour—with a degree of accuracy never approached by *any* other method. Here is *automation* in tank gauging. For illustrated booklets and full information about this great new advance in liquid level measurement, write . . .

GILBERT & BARKER MANUFACTURING COMPANY, WEST SPRINGFIELD, MASSACHUSETTS

and a 75-hp field station on the line in Gohlke field; and build a new 2000-hp compressor station at Charco, Texas.

Wilcox stated that the construction was necessary to increase the capacity of its system to meet increased requirements of Texas Eastern.

Army Engineer Troops Learn Pipe Line Construction

Officers and men from one of the Army's Corps of Engineers pipe line construction companies at Ft. Leonard, Mo., recently completed three weeks training with a Williams Brothers spread near Opelousas, La. The field training gave troops a chance to learn current construction practices, first-hand.

Southern Louisiana was selected to take advantage of the wide range of terrain conditions likely to be encountered in combat. The group was able to observe pipe line construction through heavily-timbered country, problems faced in laying pipe in boggy swamps and crossing rivers as well as hazards inherent in ditching through a caving, sandy soil.

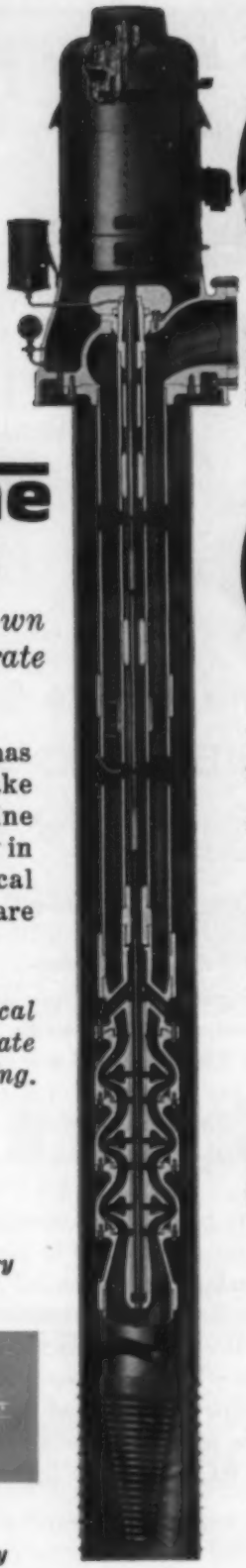
Training activity ranged from initial survey work and right-of-way preparation, through welding and laying of pipe, to testing and completion. For best training and observation, troops were paired off against opposite numbers in the spread crews.

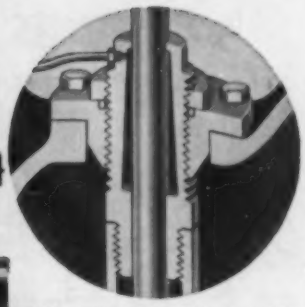
Interstate Oil Awards Work On Lake Washington Line

Interstate Oil Pipe Line Company has awarded a contract for construction of a crude oil line to serve the Lake Washington, La., field to Horton-Schoolcraft Construction Company, Inc., of Harvey, La. The line will consist of approximately 12 miles of 12-inch trunk line and 7 miles of 4- and 8-inch gathering lines and associated gathering equipment. It will initiate pipe line service in this area of the southeast Louisiana coastal marshes.

The new line will connect to Interstate's existing trunk line system from Grand Isle to Raceland, La. Ten miles of the trunk line and all of the gathering lines will lie under water. The rest of the trunk line system is in marsh country.

Contract calls for work to be completed by about November 20.



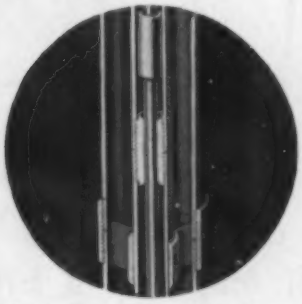


This easily accessible assembly provides means of putting tension on oil tubing, making a rigid, taut, non-vibrating bearing and shaft enclosure.

Verti-Line
PUMPS
are economical to own — economical to operate

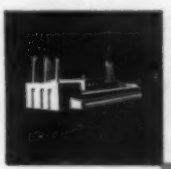
Feature after feature has been designed to make the Verti-Line Turbine Pump today's best buy in vertical pumps. Typical construction features are illustrated.

Whatever your vertical pump needs, investigate Verti-Line before buying.



1. Butt-joint column pipe is usually furnished in 10 ft. lengths.
2. Sleeve type pipe couplings are standard. Flanged type also available.
3. Reinforced rubber enclosing tube supports assure alignment of oil tube and are spaced as specified by Layne & Bowler engineers.
4. Extra long, special alloy bronze bearings are spaced at 5 ft. intervals.
5. Lineshaft is of highest quality steel, turned, ground and polished. Tested for accuracy within .002 in. High tensile strength assures greater safety.

1. Either radial vane or mixed flow type impellers are supplied depending on service and conditions.
2. Oversize pump shafts eliminate deflection, whip and vibration, resulting in longer bowl life.
3. Perihedral seal combines vertical cylindrical and horizontal surface impeller sealing. Shaft stretch due to pressure change is not critical, because of vertical cylindrical seal. However, adjustment for wear to restore original capacity is easily accomplished by means of an adjusting nut in the top of the driver that brings into action the horizontal part of the Perihedral seal — an exclusive Verti-Line feature.



in all industry

on the farm

for the city

Send for your free copy of our new booklet, "Pumps For Sale." Ask for Bulletin P-115

Verti-Line Pumps are the exclusive products of
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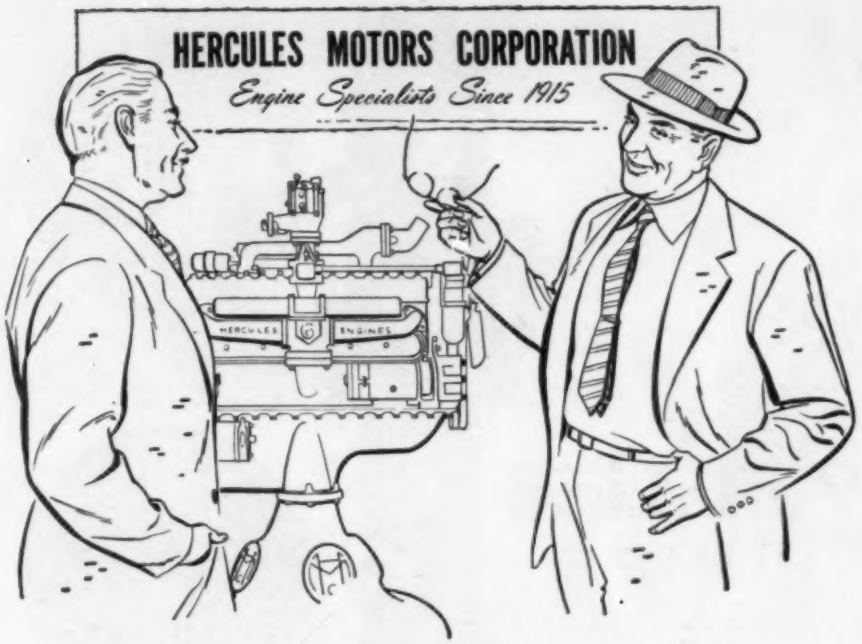
For more data on advertised products, use Readers' Service Cards, last page.



It May Cost a Little More to Buy the Best

But **HERCULES ENGINES give you**

So Much More **for your money.**

● (1) Long-life service . . . not just an idle statement. Many HERCULES ENGINES 5, 10, and 15 years old are still delivering dependable day-in, day-out power. (2) Engines designed to-the-application . . . granted, we have over 90 standard models but they are not off-the-shelf items. HERCULES ENGINES are custom-produced to specifications of the equipment. (3) Gasoline or Diesel . . . many models of gasoline engines have similar mounting dimensions as diesel engines of like displacement. (4) Wide selection of fuels . . . HERCULES ENGINES operate efficiently on any popular fuel available, permitting the use of the most economical fuel in your area . . . gasoline, diesel fuel, natural gas, kerosene, L.P.G. and others. (5) Lightweight, heavy-duty construction . . . the excess metal that adds to engine weight has been eliminated . . . all 6 cyl. engines have 7 bearing Tocco hardened crankshafts, large precision-type bearings and full length water jackets are some of the extras which are standard on HERCULES ENGINES.

These are but a few of the features that make HERCULES ENGINES a better buy. For more complete information on the wide selection of Hercules Engines and Power Units, write for a copy of the folder, "Hercules Engines." This lists the many sizes of engines and their power ratings.

HERCULES ENGINES

HERCULES MOTORS CORPORATION

40 Years of Engines for Industry

137 Eleventh Street, S. E. • Canton, Ohio

Contractors Meet in Boca Raton, Florida, January 16-18

Plans are well underway for the Eighth Annual Convention of the Pipe Line Contractors Association scheduled for January 16-18, 1956, at the Boca Raton Hotel and Club, Boca Raton, Fla., according to an announcement by H. C. Price of Bartlesville, Association president.

Six hundred representatives of the pipe line construction industry are expected for the meeting. Hotel reservations are being handled through a housing committee; further announcements will be made soon. Information about the convention may be obtained from Richard A. Gump, 2232 Republic National Bank building, Dallas, executive secretary of the Association.

Midland Cooperatives Buys 85-Mile Oklahoma Line

Midland Cooperatives, Inc. has announced the purchase of an 85-mile crude oil pipe line near its Cushing, Okla., refinery from Service Pipe Line Company.

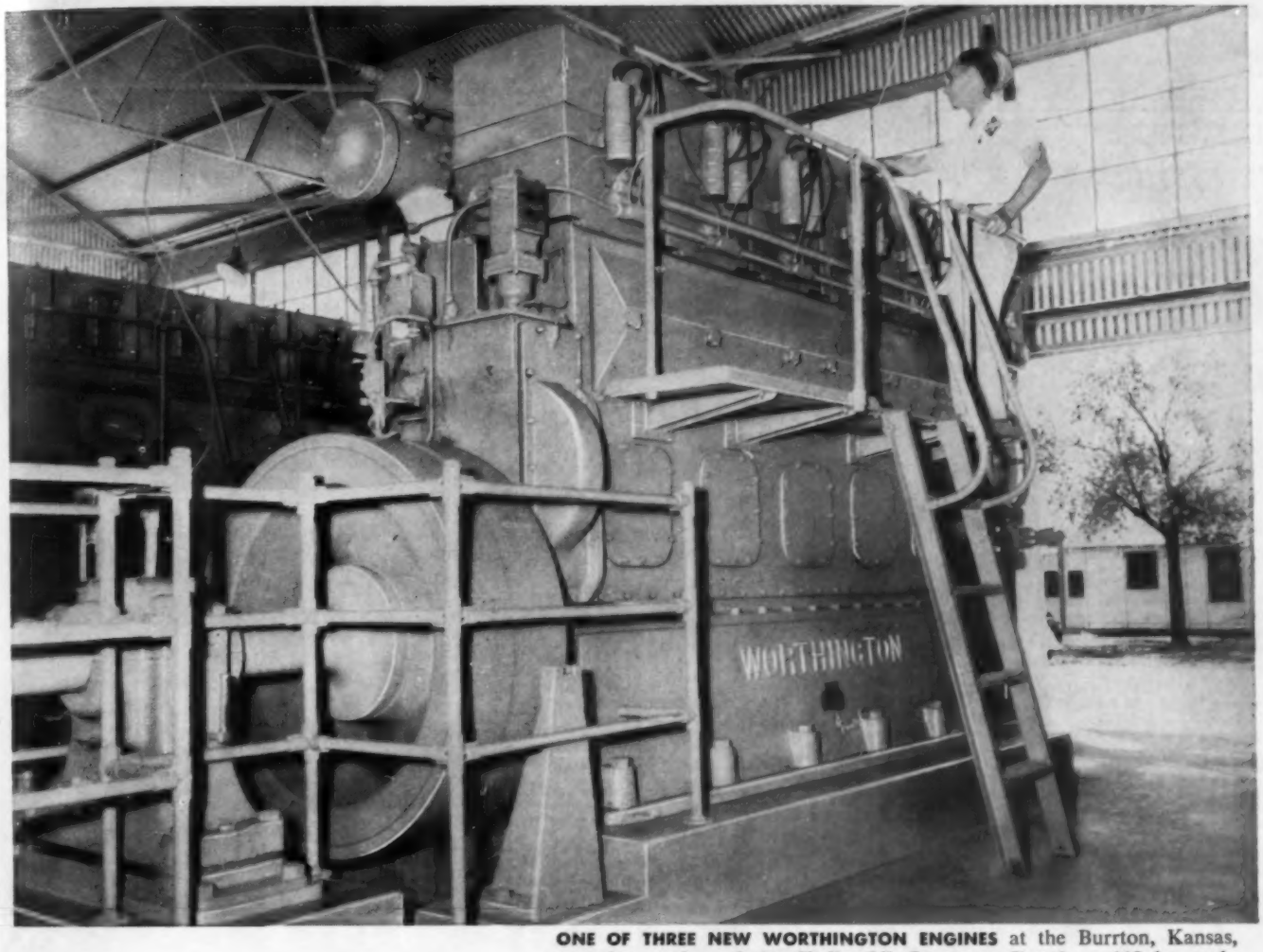
The line will be connected to Midland's tank farm at Cushing. Midland is requesting the Oklahoma Corporation Commission to restore full quotas to producers along the line. Previous owners had used only part of the line's capacity. No new connections from oil wells to the line were made during the past two years. Midland expects to take on new producers from areas along the line where new wells are coming in.

The Midland Cushing refinery is expected to use more than 3000 barrels a day of crude from the line within a year.

Shell Oil to Open New Niles, Michigan, Terminal

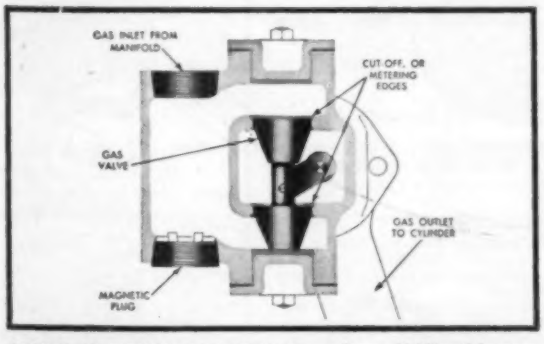
Shell Oil Company will open a new 137,000-barrel terminal on the Wolverine Pipe Line Company at Niles, Mich., late this year. The new terminal will consist of four major storage tanks, a building for office space and utilities, a four-spot truck loading rack and tank-car loading facilities.

Wolverine has a 16-inch common carrier line from Hammond, Ind., to Detroit and Toledo having an ultimate capacity of 160,000 barrels of products a day. Shell, Cities Service Oil Company and The Texas Company own the line jointly. Shell designed the line, supervised construction and is now operating the line.



ONE OF THREE NEW WORTHINGTON ENGINES at the Burrton, Kansas, pumping station of the Skelly Oil Company. Rated at 445 hp each, these engines drive centrifugal pumps through step-up gears.

Skelly Oil buys three more Worthington engines



MICRO-METERING GAS VALVES used on all Worthington spark-ignition and dual-fuel engines assure equal cylinder loading, smooth running at all loads, better speed regulation, and lower maintenance.

You find out a lot about the performance of engines when you live with them 16 years.

Skelly Oil Company had that long to assess two Worthington gas engines installed in 1936 in their old pumping station at Burrton, Kansas. Driving centrifugal pumps through step-up gears, the Worthingtons did a fine job in moving crude oil 52 miles to the Skelly refinery in El Dorado. So when the time came to rebuild the Burrton Station with enlarged capacity, Worthington engines again received the nod from Skelly engineers.

Repeat business like this isn't exactly a surprise to Worthington. But it's still good to know that our old customers — people who have given our engines a real workout for years — keep coming back to us for additional equipment. Let us help with *your* power problems — write Worthington Corporation, Engine Division, Section E.4.6, Buffalo, New York. E.4.6

SEE the Worthington Corporation Exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 41st Street.

WORTHINGTON

Economical, Continuous Power — Diesel, Dual-Fuel and Spark-Ignition Engines, from 200 to 5000 bhp.

Pipe Line Contracts Not Let

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Alabama-Tennessee Natural Gas Co.—Florence, Ala.	25	8, 12	Gas	Colbert County, Ala. loop.	$808,450	Authorized
American Gilsonite Co.	80		Gilsonite Slurry	Bonanza, Utah—Western Colorado, refinery	.....	Planned
American Pipe Line Corp.—New York City (Swinerton & Walberg, Engineering)	1,425 plus 485 miles feeders & distribution lines	24, 26	Products	Beaumont, Texas area—Newark, N.J.	$170 million	Approved ODM
Arapahoe Pipe Line Co.	41	10-12	Crude	Kimball County, Nebr.—Merino, Colo.	.....	Proposed
Arkansas-Louisiana Gas Co.	66	24	Gas	Arkansas, Louisiana and Texas loops	$9,245,166	Authorized
Az-Mex Pipe Line Co.	900	8, 12, 14	Crude	Guernsey, Wyo.—Phoenix, Ariz.	$31 million	Planned
H. W. Bass & Sons, Inc.	152	4, 6	LPG	Live Oak County, Texas—Corpus Christi, Texas	.....	Planned
Bell Oil and Gas Co.	140	6-8	Products	Ardmore—Cushing, Okla.	.....	Planned
Big Horn Pipe Line Co.—Cheyenne, Wyo.	150	8	Crude	Ash Creek, Wyo. field—Midwest, Wyo.	.....	Planned
California-Oregon Pipe Line System	103	6	Crude	Crescent City, Calif.—Medford, Ore.	$2 million	Planned
Carolina Natural Gas Corp.—701 Wilder Bldg., Charlotte, N.C.	185	2, 12	Gas	North and South Carolina	.....	Proposed
Central Hudson Gas & Electric Co.	48	12	Gas	Albany—Kingston, N.Y.	.....	Applied to FPC
Central Kentucky Natural Gas Co.	24	20, 24	Gas	Cold Springs—Anderson Ferry, Ky.	$2.5 million	Before FPC
Cities Service Gas Co.—1st National Bank Bldg., Oklahoma City, Okla.	39	20, 26	Gas	To replace lines in Kansas and Missouri	$1,860,000	Authorized
	13	....	Gas	Lafayette County, Kansas	$285,000	Authorized
	15.5	16	Gas	Carter County—Garvin County, Okla.	$541,050	Authorized
Clinchfield Coal Corp.—Dante, Va.	16	12	Gas	Dickenson County, Va.—Osborne Gap, Ky.	$785,000	Authorized
Coastal Transmission Corp.—Houston, Texas	500	30	Gas	McAllen, Texas—Louisiana connection, Houston, Texas Gas.	$70 million	Considered
Coast Counties Gas & Electric Co.—369 Pine St., San Francisco	40	3, 4, 8	Gas	Coast and Valley region, Calif.	.....	Planned
Colorado Interstate Gas Co.	115	4, 6, 8	Gas	Denver—Julesburg Basin—Basin Cities	.....	Before FPC
	328	16, 18	Gas	LaPlata County—Pueblo, Colorado Springs and Denver	$21,600,000	Authorized
Compania del Oleoducto Buenaventura—Cali, Colombia, S.A.	90	....	Products	Buenaventura—Cali, Colombia, S.A.	$4 million	Planned
Consolidated Gathering Systems, Ltd.	198	....	Crude	Sturgeon Field—Edmonton.	.....	Planned
Consolidated Natural Gas Corp.—New York	112	....	Gas	In Ohio—Plus other smaller lines	$6 million	Planned
Cosden Petroleum Corp.—Big Spring, Texas	100	6	Products	Big Spring—Abilene, Texas	$1.5 million	Proposed
Deep Rock Gas Co.	120	6	LPG	Tioga, N.D.—Canadian border	.....	Planned
El Paso Natural Gas Co.—El Paso, Tex.	500	34	Gas	Parallel from San Juan Basin to Topock, Ariz.	.....	Proposed FPC
	31.9	8	Gas	Pinal County, Ariz. Service Line.	.....	Before FPC
	119	3-6	LPG	Bloomington—Gallup, N.M.	.....	Planned
	62	14	Gas	Coke County—Midland County, Texas	$2.2 million	Authorized
Empresa Nacional del Petroleo	80	6	Products	Concon—Santiago, Chile	.....	Planned
Freedom-Valvoline Oil Co.	34	8	Products	Harpster—Findlay, Ohio	$700,500	Planned
Governments of Southern Rhodesia and Portuguese South Africa	200	....	Products	Beria, Portuguese Mozambique—Umtalia, Southern Rhodesia	.....	Considered
Hope Natural Gas Co.—445 W. Main St., Clarksburg, W. Va.	33	8, 10, 12	Gas	Wyoming County, W. Va.—Buchanan County, Va.	.....	Proposed
Houston Texas Gas & Oil Co.—4604 Main St., Houston	961	12-30	Gas	Baton Rouge, La.—Miami, Fla.	$110 million	Before FPC
Idaho Natural Gas Co.—Goodland, Kansas	....	....	Gas	Pacific Northwest line—points in Southern Idaho	.....	Proposed
International Pipe Line Co., Inc.—227 N. Colfax Ave., Minneapolis, Minn.	132	8	Products	Wrenshall, Minn.—Minneapolis Bulk Terminal	$4,250,000	Planned
Interprovincial Pipe Line Co.	120	24, 26	Crude	Cromer, Manitoba—Clearbrook, Minn.	$9 million	Proposed
Iraq Petroleum Co.	75	24	Crude	Homs, Syria to Tripoli, Lebanon	.....	Proposed
Lateral Gas Pipe Line Co.—Cedar Rapids, Iowa	27	4	Gas	Grant—Clarinda, Iowa	$267,000	Proposed
Lone Star Gas Co.—Dallas	230	22, 26	Gas	Cotton County, Okla.—Fritch, Texas	$18.7 million	Before FPC
	205	....	Gas	Snyder, Texas to tie in with Cotton County, Okla.—Fritch, Texas line	.....	Before FPC
Malco Pipe Line, Inc.	91	6	Products	Prewitt, N.M.—Albuquerque	$1,250,000	Planned
Manufacturers, Gas, Light, and Heat Co.	72	16-20	Gas	Doddridge, Wetzel, and Marshall Counties, W. Va.	.....	Planned
	213	3-26	Gas	Various locations in Pa., W. Va., and Ohio	.....	Planned
	40	....	Gas	Allegheny, Washington, and Beaver Counties, Pa.	.....	Planned
Mayflower Pipe Line Co.-(Pine Tree Natural Gas Co.) —70 Pine St., New York, N.Y.	200	10	Products	New Jersey refining area—New England	.....	Planned
Michi, Inc.	222	10	Crude	Highland, Ind.—Alma, Mich.	.....	Planned
Michigan-Wisconsin Pipe Line Co.—500 Griswold, Detroit	252	4-24	Gas	Various locations in Illinois and Wisconsin	$11 million	Proposed
Midwestern Gas Transmission Co., Houston, Texas	1112	....	Gas	Emerson, Manitoba—Nashville, Tenn.	$98 million	Before FPC
Mississippi River Fuel Corp.	190	10-18	Gas	Laterals in Woodlawn and Wasko Gas Fields, Texas	.....	Planned
Missouri Central Gas Co.	25	6	Gas	Moberly—Macon, Mo.	.....	Proposed
Missouri Public Service Co.—Warrensburg, Mo.	136.4	8-10	Gas	New Franklin, Mo.—Grundy County, plus laterals	$5 million	Proposed
Montana-Dakota Utilities Co.—Minneapolis	56	2, 4, 6	Gas	Hettinger and Stark counties, N.D.	$728,854	Authorized
	44	....	Gas	Various locations in S.D. and Wyoming	$1,414,200	Authorized
	41.8	12	Gas	Williams County, N.D.	$1.4 million	Before FPC
Moore-Stoner Co.	200	6	Products	Glendive, Mont.—Minot, N.D.	$2.5 million	Planned
NATO	1920	4-10	Products	To serve military bases in Western Europe	.....	Foster-Wheeler Prime Contractors, 425 miles let
Natural Gas Pipe Line Co. of America—20 N. Wacker Dr., Chicago	350	20, 26	Gas	Wise County, Texas—Fritch, Texas	$28.5 million	Before FPC
Natural Gas Producers, Inc.—Colorado Springs	61.8	12	Gas	Yenter Pool—Denver	$1,374,000	Planned
	49	10	Gas	Denver-Julesburg Basin—Fort Morgan, Brush and Denver	.....	Planned
Nevada Natural Gas Co.	114	12, 16	Gas	Various loops along Needles, Calif.-Las Vegas, Nev. line	$2.5 million	Planned
New River Gas Co.	50	....	Gas	Summers-Monroe Counties, W. Va. and Narrows and Dublin, W. Va.	.....	Planned
New York State Natural Gas Corp.	56.5	30	Gas	Tioga County, Pa.	$7 million	Before FPC, 12 miles Authorized
NNCW Pipe Line Co.—Dallas, Texas	127	8, 10	Crude	Clareton Field—Casper, Wyo.	$3.6 million	Planned
Northern Natural Gas Co.—2223 Dodge St., Omaha	167	24	Gas	Farmington, Minn. to Duluth, Minn. and Superior, Wis.	$12 million	Before FPC
	....	....	Gas	To interconnect with Natural Gas Pipe Line	$244,000	Planned
	28.4	30	Gas	Test lines to underground storage near Redfield, Iowa	$4.8 million	Before FPC
	15	24	Gas	To main line in Nebraska	.....	Before FPC
	163	10, 12	Gas	Various locations in South Dakota, plus 307 miles of branch lines	.....	Before FPC
	6	6	Gas	Iowa loop and compressor additions in Texas	$760,000	Before FPC
Northwestern Utilities, Ltd.—10124-104th St., Edmonton, Alberta, Canada	42	12	Gas	Bonnie Glen—Edmonton, Alberta	$1.4 million	Proposed
Pacific Gas & Electric Co.	190	34	Gas	Various loops, between Topock, Ariz.—Milpitas, Calif.	$4 million	Proposed
Pacific Northwest Pipe Line Corp.—M & M Bldg., Houston	1466 plus 443	22, 26	Gas	San Juan Basin—Pacific Northwestern states	$163 million	Contracts let for 1221 miles
Pawnee Pipe Line Co.	15	8	Crude	Northeast Colorado Sector—Denver-Julesburg, Basin	.....	Planned
Permian Basin Pipe Line Co.	11	6	Gas	Lea County, N.M.	.....	Before FPC
Petroargentina	370	16	Crude	Newguen—Bahia Blanca, Argentina	$40 million	Planned
Petroleos Mexicanos—Ave. Juares, 94, Mexico City	440	20	Gas	Brazil—Tampico—Posa Rica, Mexico	.....	Planned
	260	6, 8	Products	Lagos, Mexico—Guadalajara, Aguascalientes and Salamanca	.....	Planned
	145	12	Crude	18 de Marzo Field—Monterrey, Mexico	.....	Considered
Phillips Petroleum Co.—Bartlesville	54	6	Products	Goldsmith—Borger, Texas	.....	Planned
	50	....	Ethylene	Sweeny—Pasadena, Texas	.....	Planned
Pioneer Natural Gas Co.	261	3-22	Gas	Various locations in Texas Panhandle	.....	Planned
S. & M. Pipe Line Co., Ltd.	100	8-10	Crude	Midale, Frobisher, Steelman, Lampman, Alida, and Nottingham, Sask. to Cromer, Manitoba	$4.5 million	Proposed
Salt Lake Pipe Line Co.	....	....	Products	El Paso, Texas—Albuquerque, N.M.	$4 million	Planned
Santos Jundiai Railway Co.—Brazil	....	8, 14, 22	Crude & Products	Expansion of Santos—Sao Paulo system	$5 million	Planned

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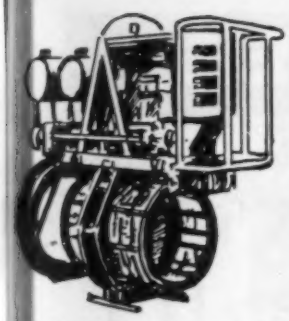
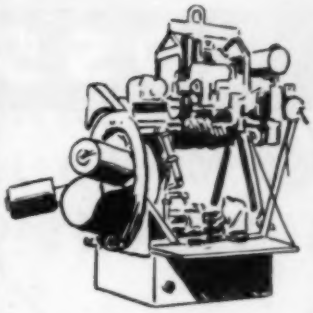
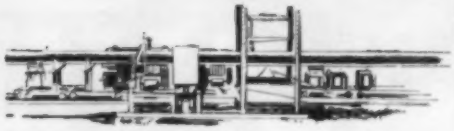


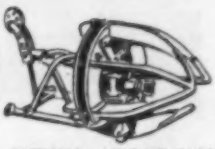
COUNTER-ROTATING CLEANING AND PRIMING MACHINES



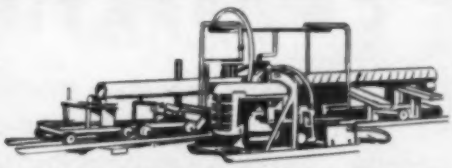
SPRAY-RING TYPE COATING AND WRAPPING MACHINES



STATIONARY CLEANING AND PRIMING MACHINES
FOR PORTABLE OR PERMANENT INSTALLATIONS

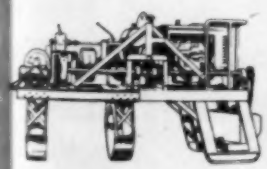


INTERNAL LINE-UP CLAMPS
AIR OR MANUALLY OPERATED

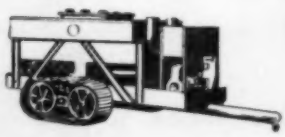


STATIONARY COATING AND WRAPPING MACHINES
FOR PORTABLE OR PERMANENT INSTALLATIONS

PIPELINE CRADLES
FOR EASY ROLLING ACTION UNDER LOADS



ROAD BORING MACHINES
FOR 4" TO 48" CASING



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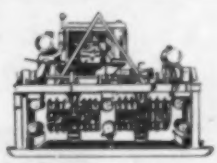

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Pipe Line Contracts Not Let—(Continued)

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
South Alberta Pipe Line, Ltd.	46	10	Gas	Etzikom Field—Medicine Hat, Alberta	$1 million	Proposed
Southern Calif. Gas Co. and Southern Counties Gas Co.	278	30	Gas	Topock, Ariz.—Los Angeles	$31 million	Planned
Southern Natural Gas Company	39	....	Gas	Various locations in Ga. and La.	$2.2 million	Authorized
Standard Pipe Line Co.	350	16	Crude	Glendive, Mont.—Guernsey, Wyo.	.....	Before ODM
	330	16	Crude	Wink, Texas—Albuquerque, N.M.	.....	Before ODM
Stanmount Pipe Line Co.	140	10	Crude	Cayiga and Beaver Lake Fields, N.D. to connect with Interprovincial Pipe Line	.....	Planned
Sturgeon Pipe Line, Ltd.	100	12	.....	Sturgeon Lake Field—Trans-Mountain system	$6,500,000	Planned
Sunflower Pipe Line Co.—Tulsa, Okla.	265	3-6	LPG	Kearny, Grant and Haskel Counties, Kansas—Wichita, Kansas	$3.5 million	Authorized
Tennessee Gas Transmission Co.—Box 2511, Houston (See also Midwestern Gas Transmission Co.)	220	26, 30	Gas	Loops in Kentucky and Ohio plus 376 miles of Supply	$56 million	Authorized
	100	....	Gas	Gathering lines in Texas and Louisiana plus station additions	$18.6 million	Before FPC
	102	....	Gas	Loop Lines in Kentucky, Ohio, and Pennsylvania	$24.3 million	Before FPC
Texas Eastern Transmission Corp.	400	....	Gas	Near Reynosa, Mexico—Beaumont, Texas	.....	Planned
	1,050	....	Gas	Border near Emerson, Manitoba—Nashville, Tenn.	.....	Proposed
Texas Eastern Transmission Corp. and Texas Eastern, Penn-Jersey Corp.	11	....	Gas	Loops in Philadelphia area plus compressor facilities	$2.4 million	Authorized
Texas Gas Transmission Corp.	198	20	Gas	East Lake Palourde, La.—main trans. line	$20 million	Before FPC
Texas—Ohio Gas Co.	....	10	Gas	Connection with Transco line to Carolina and Georgia points	.....	Considered
	....	....	Gas	Houston, Texas—Miami, Fla.	.....	Considered
Trans-Canada Pipe Line, Ltd.—Calgary, Alberta	2240	30, 36	Gas	Alberta—Eastern Canada	$297 million	Planned
Transcontinental Gas Pipe Line Corp.—3100 Travis St., Houston	....	....	Gas	Connecting facilities with Texas Eastern Penn-Jersey in Pennsylvania and New Jersey	$131,628	Authorized
	24.2	....	Gas	Gathering Lines from South Bayou Mallet, Maxie and Happytown Fields, La.	$754,000	Authorized
	27	....	Gas	Loops in La., Ga., N.C., Va., and Md.	$3,426,000	Authorized
Triangle Pipe Line Co.	560	12	Products	Arkansas City, Ark.—Covington, Ky.	$24.5 million	Proposed
Union Gas Co. of Canada, Ltd.—Chatham, Ontario	180	24	Gas	Dawn Gas Field to Lamberton County to deliver gas to Dominion Gas Co.	.....	Planned
Union Oil Co. of Calif.	815	....	Shale oil Products	Rifle, Colo.—Los Angeles	$56 million	Planned
United Gas Pipe Line Co.	63	16, 20	Gas	Various locations in Miss., Ala. and Florida	$8.3 million	Authorized
United Natural Gas Co.	50	12	Gas	Elk County—Jefferson County, Pa.	.....	Planned
U. S. Dept. of Defense	97	....	Crude	Elk Hills Naval Reserve—Los Angeles	$8 million	Considered
U. S. Navy	450	8	Gas	Gubik Field—Fairbanks, Alaska	$20 million	Planned
Utah Natural Gas Co.	40	16	Gas	Ovem—Salt Lake City, Utah	.....	Planned
Virginia Natural Gas Co.	153	....	Gas	Buckingham—Richmond and Portsmouth, Va.	.....	Planned
Warren Petroleum Co.	54	4-30	Gas	Lea County, N.M.	.....	Planned
Washington Gas Light Co.—Washington, D.C.	11	24	Gas	Chillum Station—Gordon's Corner, Md.	$2 million	Authorized
West Coast Pipe Line Co.—Mercantile Bank Bldg., Dallas	960	24, 26	Crude	Wink, Texas—Norwalk, Calif.	$106 million	Planned
Westcoast Transmission Company, Ltd.	650	30	Gas	Peace River Fields—Sumas, Wash. Connecting with Pacific Northwest Pipeline—Second Line	$140 million	Planned
Westspur Pipeline Co.	95	....	Crude	Midale, Lampman, Steelman, Frobisher, Alida, and Nottingham fields, Sask. to Cromer, Manitoba	.....	Before Dom. Board of Trans. Comm.
Wilcox Trend Gathering System, Inc.	16	16	Gas	Gathering lines to Provident City, Texas	$2.9 million	Before FPC
Winnipeg and Central Gas Co.	450	4-8	LPG	Tioga, N.D.—Winnipeg, Canada	$20 million	Planned
Wyoming Gas Products Corp.	....	....	Gas	Gathering system in Weston County, Wyo. to feed gasoline plant	.....	Planned
Yacimientos Petroliferos Fiscales Bolivianos	170	4	Crude	Bermejo—Tupinza, Bolivia	.....	Planned

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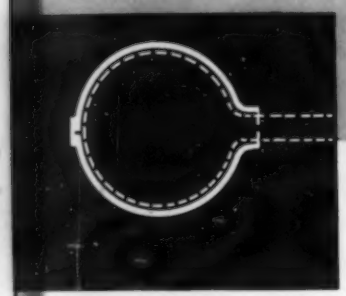

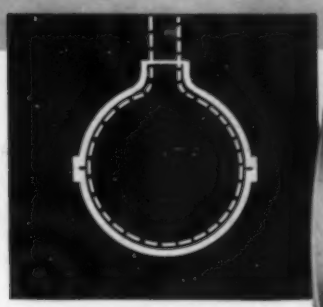

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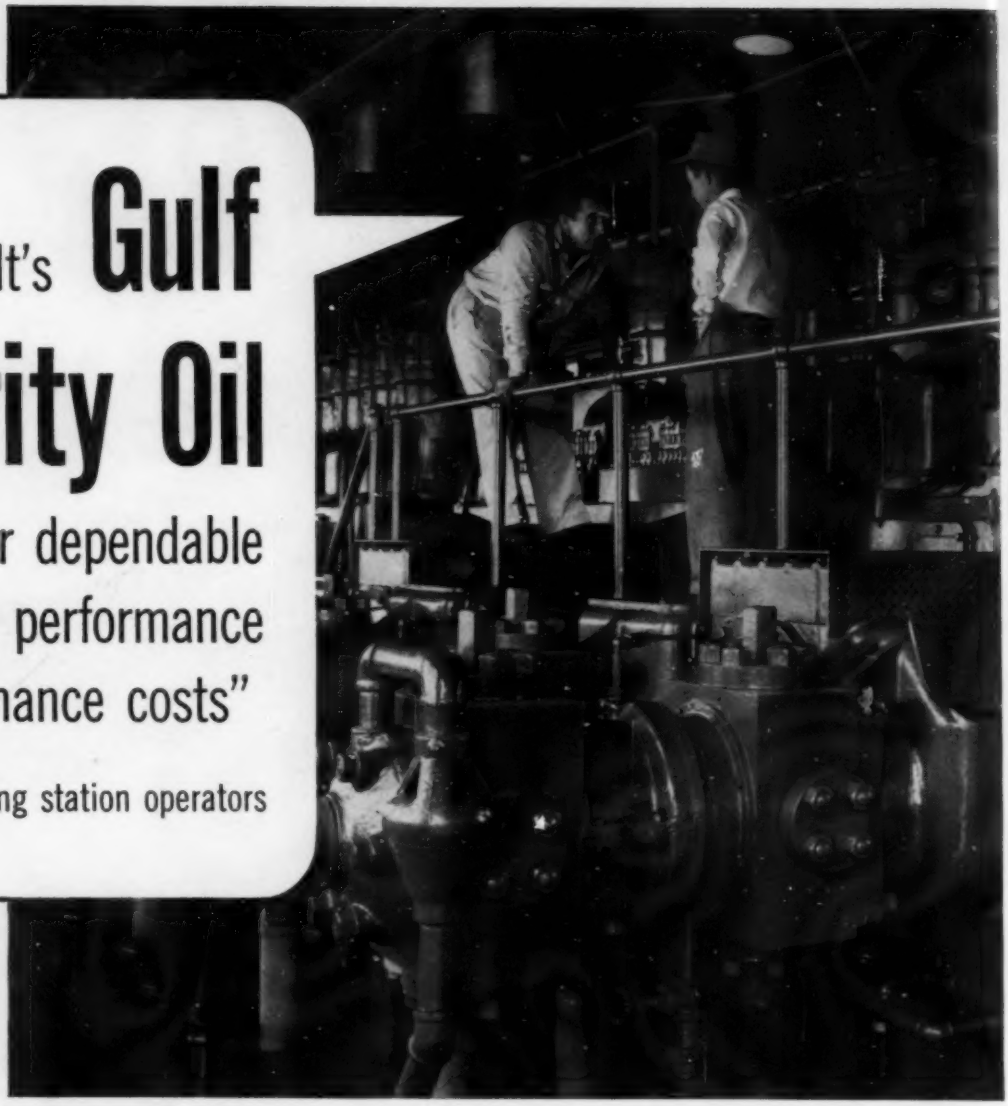
say pumping station operators



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Pipe Line Men

IN THE NEWS

Veteran Sinclair Lineman Honored

James C. Locke, veteran lineman for Sinclair Pipe Line Company and predecessor companies, was honored at a banquet in Tulsa prior to his retirement after 39 years of service. Left to right are L. E. Cook, superintendent of communications for Sinclair Pipe Line Company at Independence, Kansas; Locke; and D. R. Welsh, former Sinclair communications superintendent.

D. M. Morrison has been elected president of **Trans-Mountain Oil Pipeline Company,** Vancouver, B. C. He formerly was vice president of Shell Oil Company of Canada, Ltd.

•

Promotion of **Clifford O. Nielson** to division chief engineer for **Service Pipe Line Company's** Kansas division recently was announced. With the Kansas Highway Commission before joining Service in 1941, he started as an instrument man, advancing to engineer in 1948. He has been headquartered at Wichita since 1950.

•

Appointment of **Floyd R. Cramer** as plant superintendent in the Texas Pipeline division of **Southern Counties Gas Company** has been announced. Formerly assistant plant superintendent, he succeeds **Glenn Y. Vail** who resigned to accept a position with the Pacific Northwest Pipeline organization.

Cramer began his gas company career in 1940 when he joined Southern California Gas Company. He has been a member of the Texas Pipeline division since 1948 and actively has participated in development of the division's compressor plants.

Dr. George G. Oberfell of Bartlesville, Okla., was elected a director of **Texas Gas Corporation** and its subsidiary companies at a special meeting recently held in New York. He also will serve as a consultant to the Texas Gas organization.

Oberfell is a recognized authority on petroleum research. He was director of research of Phillips Petroleum Company from 1925 to 1933; vice president in charge of research and development at Phillips from 1933 to 1950, and also served as a member of the Phillips board of directors and executive committee. He retired from Phillips in 1950, continuing, however, in a consulting capacity.

John L. Buvens, previously manager of crude oil, gas supply and sales, has been elected a vice president of Texas Gas and subsidiary companies. He will retain his former duties.

•

John G. Montfort recently joined **Southern Pacific Pipe Line Company** as district superintendent. He formerly was district superintendent for Mid-Valley Pipeline Company.

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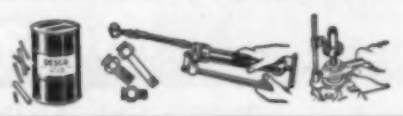


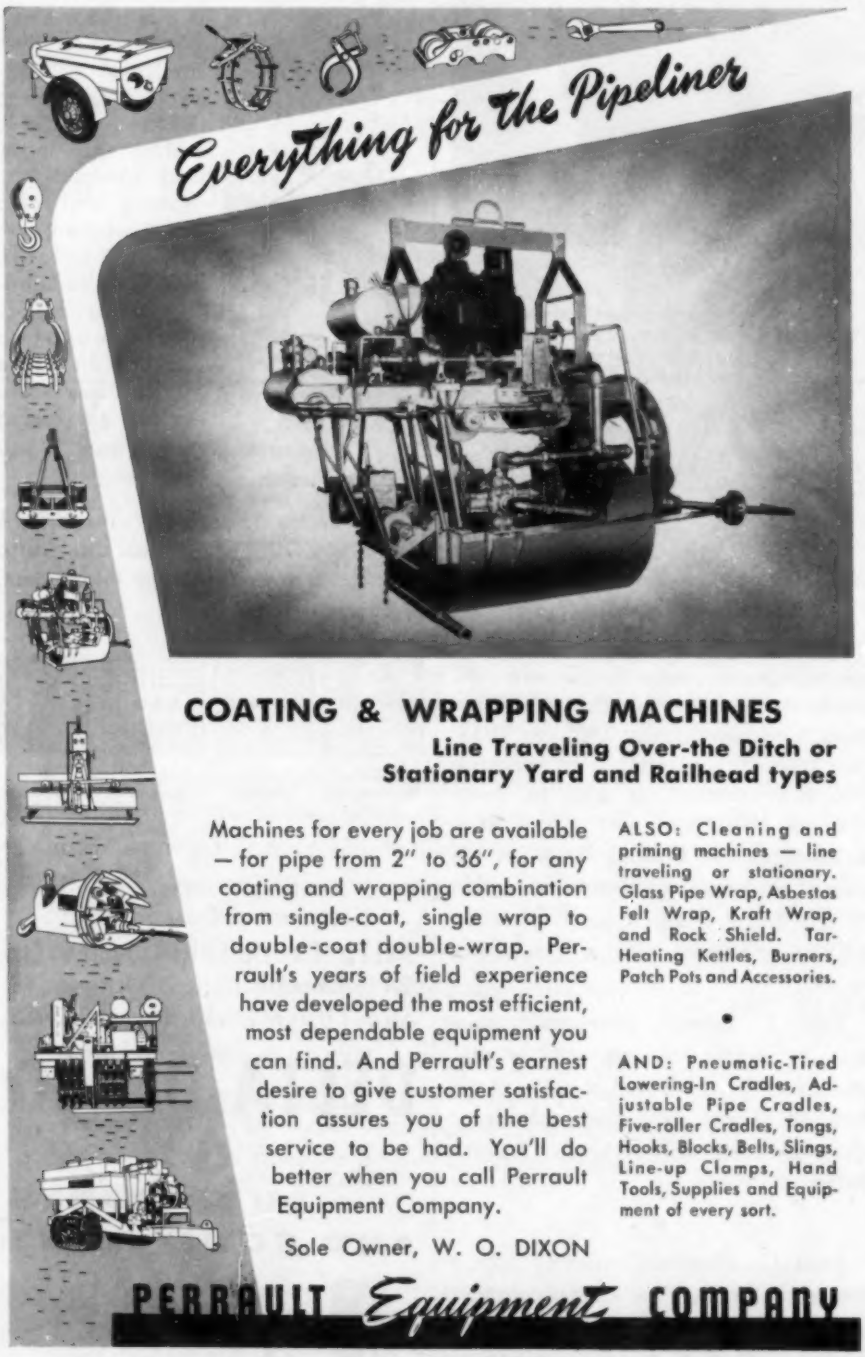
LUBRICANTS FITTINGS GUNS LUBRICATORS

The appointment of **William L. Dunlap, Jr.**, as a district superintendent for **Mid-Valley Pipeline Company** has been announced. Dunlap started his career as a field pumper in the East Texas division of Sun Pipe Line Company in 1933. While with Sun, he worked as assistant main line engineer, main line engineer and station engineer in the East Texas area.

At the start of operations of Mid-Valley, Dunlap transferred as station foreman at the Mayersville, Miss., pump station, which position he has held to this time.

Edward Hamric, staff engineer for the Pipeline department of **Texas Gas Transmission Corporation** for the past four years, has been appointed assistant to the superintendent. Joining Texas Gas as an engineer in 1948, he was assistant to the Pipeline Division I superintendent at Memphis prior to becoming staff engineer for the department.

In his new position, Hamric will assist Superintendent W. A. Johnson in all phases of departmental operations throughout the company's 3000-mile pipe line system.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AND: Pneumatic-Tired Lowering-In Cradles, Adjustable Pipe Cradles, Five-roller Cradles, Tongs, Hooks, Blocks, Belts, Slings, Line-up Clamps, Hand Tools, Supplies and Equipment of every sort.
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TELEPHONE 5-1103 • 1130 NORTH BOSTON • TULSA 6, OKLAHOMA
EXPORT OFFICE: SUITE 1655, 45 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Election of **Neal B. Prichard** as vice president of manufacturing of the **Anderson-Prichard Oil Corporation**, has been announced. He succeeds **George H. Burress**, who retired recently after directing the company's manufacturing and pipe line activities for 29 years.

Neal B. Prichard

Prichard joined the firm in 1931 at the Col-Tex Refinery. In 1946 he was transferred to the general office in Oklahoma City to assist Burruss. In 1948 Prichard became a member of the company's board of directors.

•

J. E. Mims has been named manager of **Shell Pipe Line Corporation's** operating division in Casper, Wyo. The new Rocky Mountain division will operate facilities of the Butte Pipe Line Company, now under construction in eastern Montana and Wyoming, and Shell Pipe Line's wholly-owned facilities in northeastern Colorado.

Mims, who has been superintendent of Shell Pipe Line's Rancho division with headquarters at Austin, Texas, joined the company in 1942 as a draftsman. He became an engineer in 1946 and later served as superintendent of the Ozark division before being made Rancho superintendent in 1952.

•

Herman Dempsey, foreman of **Lone Star Gas Company's** Fort Worth Pipe Line district, has been named assistant superintendent of the Pipe Line department. Joining Lone Star in 1929, he has served as laborer, dispatcher, field clerk, assistant foreman and district foreman and has been headquartered at Ranger, Ballinger and Fort Worth.

Also named to a higher post was **Earl Miller**, construction foreman, who has been named district foreman of the Fort Worth Pipe Line district. He served as an engineer on construction and went into valuation work for the company in 1935. Since 1940 he has supervised major construction projects for the Pipe Line department.

Butyrate pipe cuts installation time

Tenite Butyrate's light weight and easy joining by solvent welding can cut labor installation costs by more than 60%.

Butyrate pipe cuts corrosion failures

Tenite Butyrate resists corrosion by sour crudes, brine and electrolytic soils. This Tenite section from a salt water disposal line is still in good condition after 2 years' service. On the same line, metal pipe used to fail completely in 6 months.

Butyrate pipe cuts paraffin clogging

How much time do you lose in cleaning out paraffin-clogged metal lines? The clean, smooth inner wall of a Tenite pipe offers no toe-holds for paraffin.

Could Tenite Butyrate cut costs for you?

SAVINGS BEGIN the minute you order Tenite Butyrate pipe. Its light weight saves freight, handling and distribution costs. Simple solvent welding with slip-sleeve couplings makes it fast to install. You have no expensive corrosion failure replacements, no periodic cleaning out of accumulated paraffin.

This lightweight pipe is only 1/12th the weight of cement-lined metal pipe. It has good impact resistance and performs well over a wide temperature range.

The petroleum industry has long sought a lightweight, corrosion-resisting pipe that would be strong enough to take the abuse of oil field use. Tenite Butyrate gives you this combination. Years of successful service in all types of fields prove its complete suitability for crude, corrosive water and brine lines. Mail the coupon for more information plus a list of Tenite pipe suppliers. EASTMAN CHEMICAL PRODUCTS, INC., Kingsport, Tennessee, subsidiary of Eastman Kodak Company.

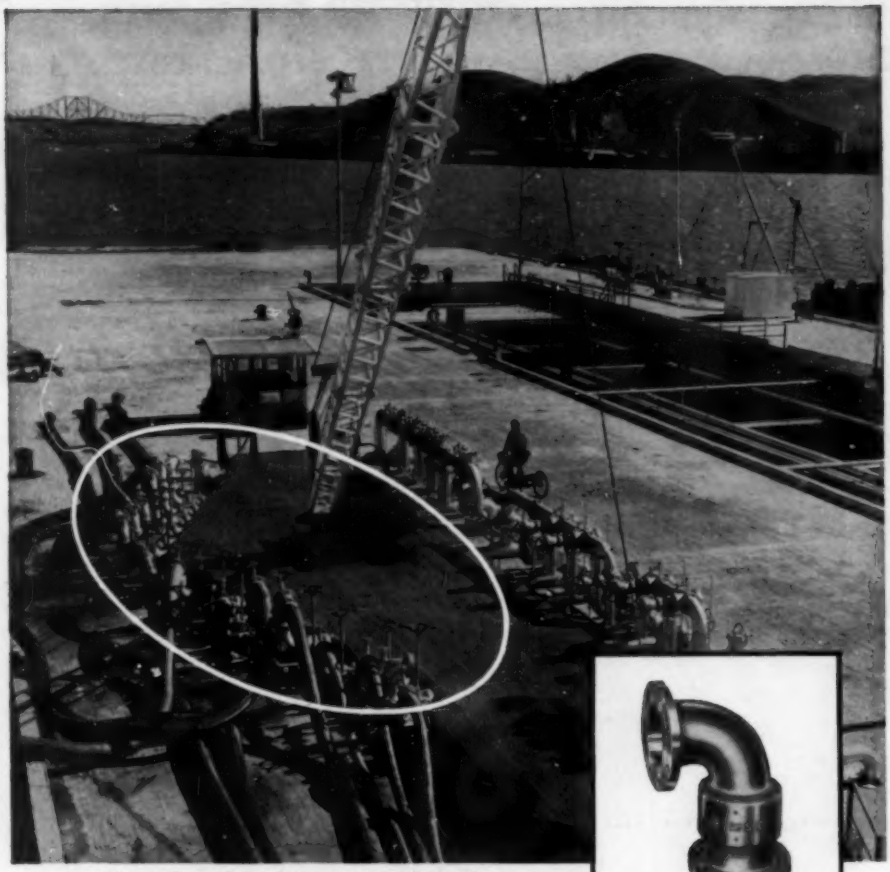
TENITE
BUTYRATE
an Eastman plastic

EASTMAN CHEMICAL PRODUCTS, INC.
KINGSPORT, TENNESSEE

Please send me information on TENITE BUTYRATE PIPE and a list of companies manufacturing Tenite pipe and fittings.

NAME .....
POSITION .....
COMPANY .....
STREET .....
CITY ..... STATE .....

PLI-1155



View of Emsco Swivel Joints on one loading station.

Emsco 8" type LP Swivel Joint Style 2 with flanged ends for loading dock service.

EMSCO SWIVEL JOINTS SELECTED FOR NEW LOADING WHARF

We are proud to have supplied the Swivel Joints installed on this loading wharf making it one of America's newest and most modern loading facilities. Here are installed a score of Emsco 6" and 8" type LP Swivel Joints. Free turning and easy maintenance were prime factors in the selection of Emsco for this job. In the cross section note how the thrust load is absorbed through the ball bearings – how easily bearings can be adjusted. Note also how readily the packing can be replaced simply by separating the joint as one would a union. No return of joint to the factory for service. Emsco assures you a new kind of dependability in Swivel Joints.

Emsco's complete line includes Swivel Joints for high or low pressure, high vacuum, corrosive or high temperature service; for gas, liquid or semi-solids. Check with us or our field representatives. Over 500 various combinations to choose from. Sizes ⅜" to 12". Pressures to 15,000 lbs. Temperatures to 750° F.

Simplicity of Emsco's patented design assures a new kind of performance and dependability in Swivel Joint construction.

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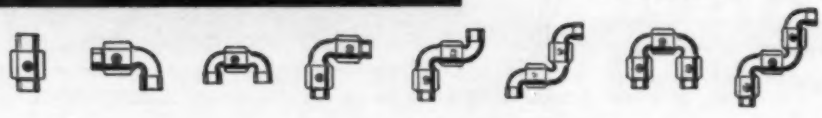
EMSCO MANUFACTURING COMPANY
Box 2098, TERMINAL ANNEX
LOS ANGELES 54, CALIF.
Houston, Texas
Garland, Texas



Byron K. Smith

William T. Eskew

Southern Pacific Pipe Lines, Inc. has made the following appointments: **Byron K. Smith,** formerly station chief of station tank farm and docks for Plantation Pipe Lines, has joined the company as assistant general manager. His headquarters will be in Los Angeles. **William T. Eskew, Jr.,** has been appointed chief engineer of Southern Pacific Pipe Lines, and **Murray A. Levy** has been appointed superintendent of products movement.

Murray A. Levy

Eskew joined Plantation Pipe Line Company in 1947 and resigned as division engineer this year to join Southern Pacific Pipe Lines in their Los Angeles headquarters. Levy, formerly scheduling dispatcher with Plantation, had been with the company since 1942.

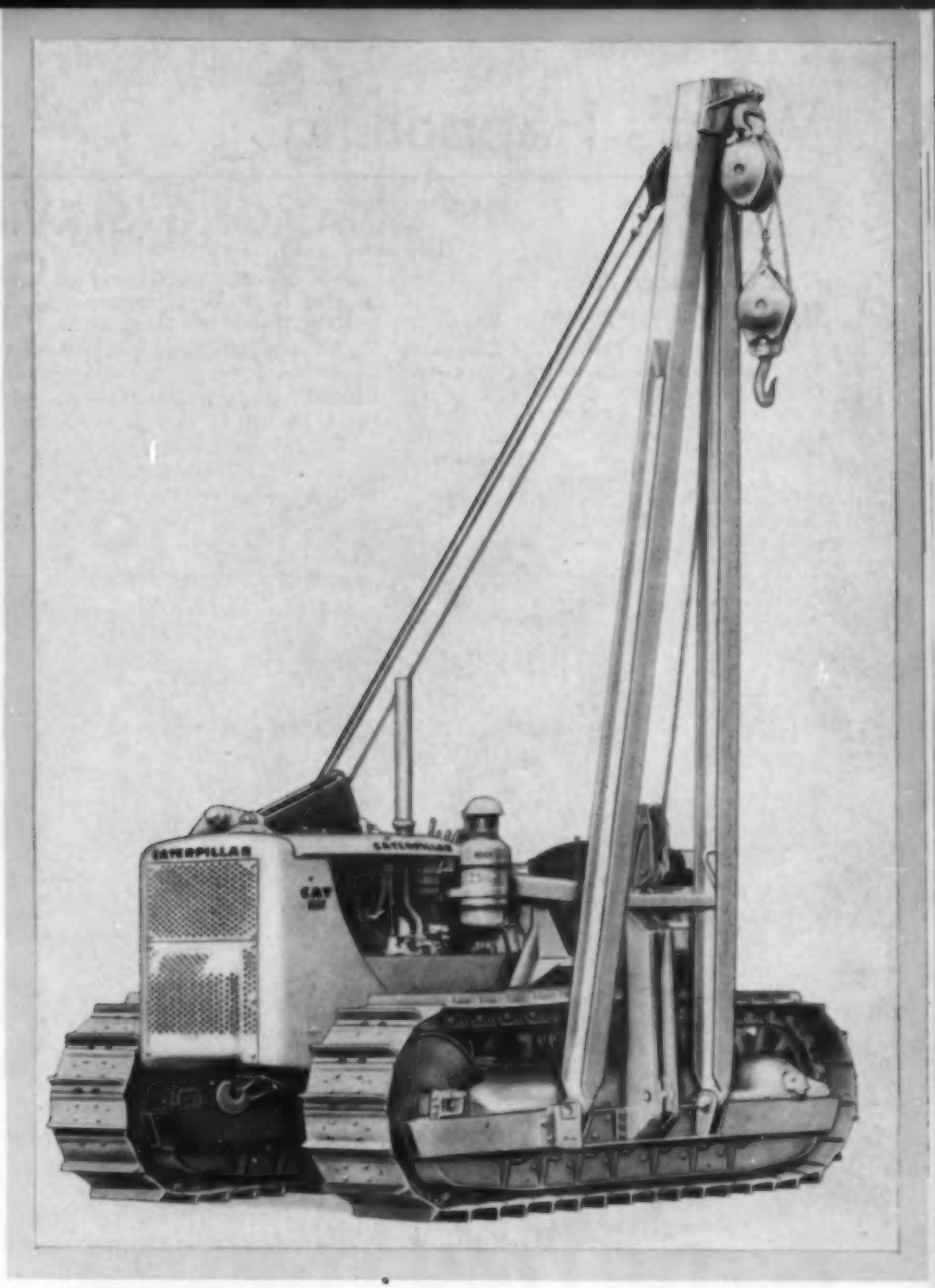
•

Appointments of two terminal superintendents have been announced by **Standard Oil Company (Indiana). W. W. Bredlow,** superintendent of Standard's Moorhead, Minn., products pipe line terminal, has been transferred to Superior, Wis. as superintendent of the marine terminal. **K. L. Emery,** chief clerk of the Moorhead terminal, has moved up to superintendent to succeed Bredlow.

Bredlow joined Standard in 1946 as assistant terminal superintendent at Moorhead, being named superintendent in 1948. During 1953 and 1954 he served as project engineer in charge of construction for Standard's temporary pipe line terminal at Mandan, N. D., and its terminal at Jamestown, N. D. Emery started as "A" station cashier in Standard's Fargo, N. D., sales division in 1944.

NOW...

EXTRA STABILITY, TRACTION AND FLOTATION AVAILABLE IN THE CAT* MD7 PIPELAYER!



To match your pipelaying requirements even better, a 7-roller track frame MD7 is now available.

The long, 7-roller track frame, made available in response to suggestions from many pipeliners, provides the extra stability, traction and flotation needed on rugged pipeline jobs. This long track frame, with 22-inch shoes, makes possible increased lifting capacity up to 54,200 pounds. Still more versatility is given you in the MD7 by the choice of a 15-foot, 18-foot, or 20-foot boom.

The rugged D7 Tractor, which powers the MD7, has long been a favorite of pipeliners everywhere, and now, with 128 HP and trouble-free oil clutch, is more in demand than ever.

Whatever your job needs, there is a Cat-built Pipelayer to match. And they're backed with excellent service by your Caterpillar Dealer. For complete facts about them, see him today!

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

PIPELAYERS TO MATCH YOUR JOB NEEDS

What's Happening

AMONG SERVICE AND SUPPLY MEN

Fluor Corporation Forms Pipe Manufacturing Firm

Formation of the Prairie Pipe Company, Ltd., of Regina, Saskatchewan, to manufacture steel pipe for the oil and gas industries has been announced by D. W. Darnell, chairman of the board of the Fluor Corporation, Ltd., and president of the new firm.

Operating as an affiliate of the Fluor Corporation, the new company's $3.5 million plant will be located on a 110-acre site outside Regina. Construction has been started by Fluor Corporation of Canada who will build the plant.

J. E. Cunningham, former district engineer for Fluor in Houston, has been named vice president and general manager. He will be located at Regina.

Capacity of the new plant will be more than 100,000 tons a year. The company will manufacture pipe from 4½ to and including 16 inches, conforming to API specifications.

Question to management...

What is the real worth of Cathodic Protection?

The real worth of cathodic protection depends primarily upon its effectiveness after it is installed. Inadequately designed or improperly installed systems will not do the job. Savings on your corrosion control costs can best be obtained with experienced E. R. P. corrosion engineers working with your staff.

Successful cathodic protection requires careful investigation and correct interpretation of all factors affecting the corrosion of any buried or submerged structure. When you use Electro Rust-Proofing cathodic protection services, you are assured of a successful installation, for E. R. P. brings to each job a background of 20 years experience in survey, design and installation of cathodic protection systems.

Your inquiry—written now—will bring our engineers to discuss your corrosion control program—without obligation.

ERP CATHODIC PROTECTION

ELECTRO RUST-PROOFING CORPORATION

30 MAIN STREET, BELLEVILLE 9, N. J.

ATLANTA CHICAGO DALLAS MONROVIA SEATTLE

E-31

Worthington Promotes Barten To Manager, Gas Transmission

Howard C. Barten has been named manager of Worthington Corporation's Gas Transmission section of Engine Sales Division. Joining the division in Buffalo in 1934, he has served as estimator, Eastern Engine Sales, at the company's New York office, and as engine specialist for the Cincinnati and Cleveland district offices. Barten returned to the Buffalo Works in 1942 as engine specialist and later was named assistant to the manager of the Engine Sales division.

Howard C. Barten

Hammel-Dahl Company Opens New Sales Office in Tulsa

The Hammel-Dahl Company announces the opening of their new sales office in Tulsa under supervision of District Sales Manager Paul E. Bowles. Bowles has had many years of field experience in diaphragm control valves and applications. He formerly has been with Black, Sivalls & Bryson and Joseph A. Coy Company.

Morgan and Burnette Promoted By Rockwell Manufacturing

Donald C. Morgan, Chicago district sales manager of Rockwell Manufacturing Company's Meter and Valve division, has been named Central regional sales manager with offices in Pittsburgh. Joining Rockwell in 1930 as sales engineer in the Chicago office, he replaces Carl C. Moore, whose retirement has been announced.

R. V. Burnette, gas sales supervisor for the Central region, succeeds Morgan as Chicago district sales manager. He joined Rockwell's sales staff in 1926 and was named gas sales supervisor for the Central region in 1949.

Donald C. Morgan

Napko Paint Company Builds New 4-Unit Plant in Houston

Construction has begun on a half-million dollar pltnt for Napko Paint Company on an eight-acre site at 5300 Sunrise Street, Houston. The four-unit plant will be of modern steel and masonry construction and will provide 50,000 square feet for Napko's factory, laboratory and offices. A three-story main factory and laboratory will include modern facilities for production of paints and other coatings. There will be separate structures for a resin plant, a finished goods warehouse and an office building.

Transco's construction...

315 MILES OF 36-INCH - - FOR LOOPS IN 1955

That is the amount of 36-inch line Transco will lay as part of 580 miles of pipeline loops to be completed before the winter heating season. In 1954, Transco laid 47 miles of this large pipe in Mississippi and Alabama. 36-inch pipe, with the same compression, will transport 60% more natural gas than a 30-inch line and almost three times as much as a 24-inch line.

A Transco innovation is the installation near Houston of a centrifugal compressor driven by a four-cycle gas engine.

To meet the expanding need for natural gas in the New York-New Jersey-Philadelphia Metropolitan Areas and in the Southern Piedmont, Transco is increasing allocations to 48 public utility, industrial and municipal customers.

TRANSCONTINENTAL GAS PIPE LINE CORPORATION

Engaged in making a Market for Texas and Lousiana Natural Gas

S&J ANTI-FREEZE DRAIN VALVES

Always on the Job!

Here's the Shand & Jurs Anti-Freeze Drain Valve that is always ready and able to draw water off the bottom of a petroleum tank. It will remain operable even during sub-freezing weather conditions. It's self draining; water will not remain inside the valve body. Obviously the valve cannot freeze up and become inoperable.

The unique design of the S&J Anti-Freeze Drain Valve, designated as Fig. ST-2001, calls for mounting in strong threaded flange or coupling welded into the tank shell so that threads do not warp. This prevents loss of product and incidental hazards, and facilitates removal of the drain valve for cleaning or maintenance.

Above: Fig. ST-2001 AV Anti-Freeze Drain Valve with auxiliary valve which permits removal of the Drain Valve from a tank without draining tank contents.

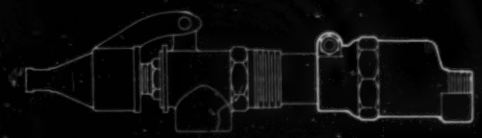
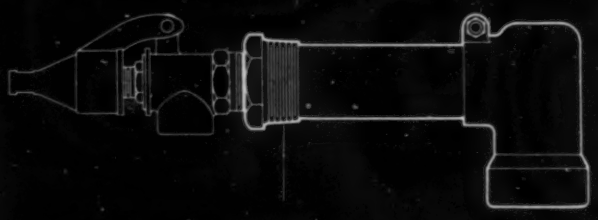


Fig. ST-2001 Anti-Freeze Drain Valve with adapter for Cone roof tanks.



The S&J Anti-Freeze Dain Valve, Fig. ST-2001 is available in 2", 3" and 4" sizes.

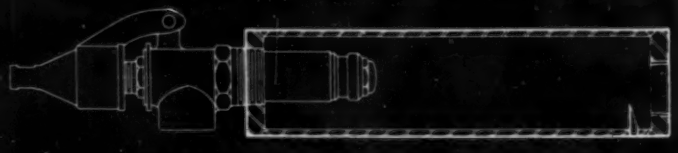


Fig. ST-2001 S Anti-Freeze Drain Valve with eccentric sleeve is designed for use in Spheroids and other tanks with curved bottoms.

Shand and Jurs Co.
BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

HOUSTON
M & M Bldg.

TULSA
Thompson Bldg.

CHICAGO
10409 S. Western Ave.

LOS ANGELES
6399 Wilshire Blvd.

REPRESENTATIVES:
SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglington East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS: Sinclair Spence, C.A.: Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham

Walter E. Schott

John E. Searcy

New Corrosion Control Firm Organized in Oklahoma

A new firm, Corrosion Control Inc., has been issued corporation papers from the state of Oklahoma. Officers are Claude L. Wright, president; Walter E. Schott, Jr., vice president; and John E. Searcy, Jr., vice president.

Corrosion Control, Inc., will furnish corrosion control engineering services to companies such as those operating pipe lines, tanks and tank farms, refineries, gasoline plants, process plants, underground cables, oil wells, heat exchange equipment and marine equipment. The primary function of the firm is that of analysis and treatment.

Schott, who has spent the past five years as a sales engineer in corrosion control, is vice president in charge of sales. Searcy has been appointed vice president in charge of engineering. He has been active in engineering and developing corrosion control practices eight years.

Gustin-Bacon Coordinates Insulation Sales Department

In a recent move to strengthen and coordinate the Insulation Sales department, Gustin-Bacon Manufacturing Company appointed F. W. Muller, manager—Insulation, Sales department. H. M. Grant was appointed assistant manager of the department, and S. E. Brelsford was assigned assistant to the manager—Insulation Sales department.

F. W. Muller

The new department merges the company's glass fiber Snap-On Pipe Insulation and Ultralite and Ultrafine Blanket Insulation Sales into one department.

Dant to Manage Permacel's Southern Sales Division

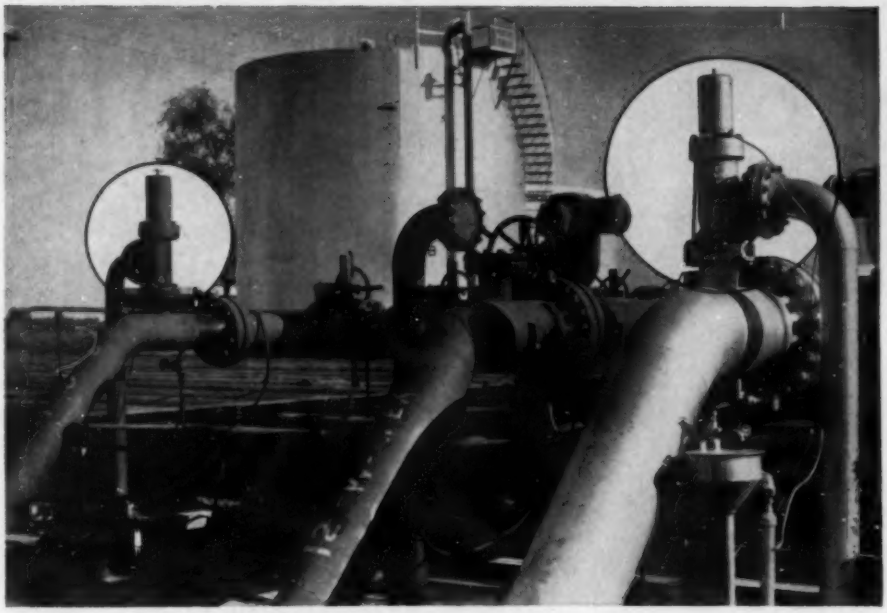
The appointment of Hale L. Dant as Southern division manager for the Permacel Tape Corporation, a Johnson & Johnson company, has been announced. Dant's headquarters will be at the division office in Atlanta.

Dant joined Permacel in 1942 after sales experience with Tropical Paint & Oil Company, S. V. Cain Paper, Capital Paper Company and R. J. Reynolds Tobacco Company. During the last two years with Permacel, Dant has been an electrical tape specialist.

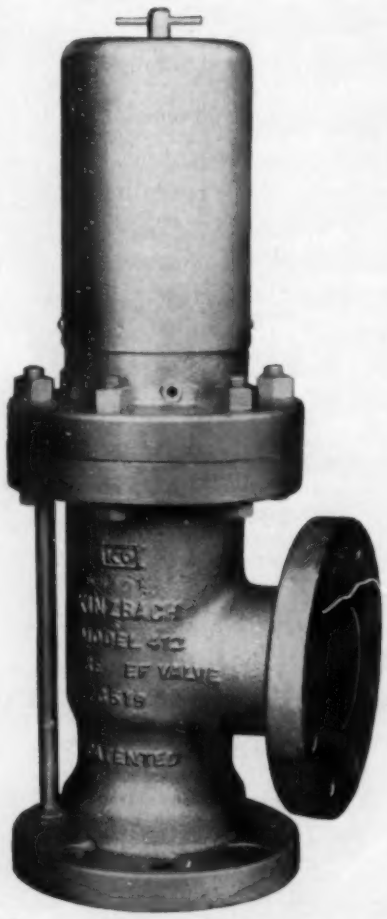
The Southern division of Permacel covers North Carolina, South Carolina, Georgia, Florida, Alabama and eastern Tennessee.

Every RIDGID Pipe Tool
TESTED
individually before shipment
Extra Fast...
...easy...pipe reaming
with this self-feeding
RIDGID
Spiral . . . turns into the work smoothly, no chatter. Famous RIDGID heat-treated cutting edges mean clean reaming, extra long service. Quick enlarging of conduit box outlets—and holes in sheet metal. More for your money—buy the 2-S at your Supply House.
for power
and hand reaming . . .
RIDGID
LonGrip
5 long straight flutes ream clean, easy to control.
RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company • Elyria, Ohio • U.S.A.



Positive Protection Against Pressure Surges



KINZBACH
MODEL 412
RELIEF VALVE
for Pipelines and Refineries

When a pressure overload in the line is reached, the Kinzbach Model 412 Relief Valve opens instantly to full capacity. This valve provides automatic resetting at a pre-determined pressure drop, positive seating and facilities for functional testing.

The Model 412 uses line pressure for opening and closing. The opening pressure is preset by application of a dead weight load. Opening and closing action is positive and reliable. The pre-set pressure never changes.

Kinzbach Model 412 Relief Valves are available in 2", 3", 4", 6" and 8" sizes for working pressures up to 1000 p.s.i. Write for Bulletin RV412 for full technical data.

KINZBACH TOOL CO INC

KINZBACH TOOL COMPANY, INC.

P. O. Box 277 Houston, Texas

Export Office: 74 Trinity Place, New York, N. Y.

John T. Hickey

Virgil E. Bottom

Three Major Appointments Announced by Motorola

Edmund G. Shower

Three major personnel appointments for the Motorola Inc. transistor manufacturing facility in Phoenix have been announced.

John T. Hickey was named general manager; Dr. Virgil E. Bottom was named director of research and development, and Edmund G. Shower was named product production manager.

Hickey, with Motorola since 1948, has been staff assistant in charge of the transistor operation since the beginning of the project. Bottom, since 1953, has been development physicist in charge of the solid-state devices group in Motorola's Phoenix laboratories. Shower, joining the company to assume his new position, has been director of the transitor division at National Union Electrical Corporation since 1952.

Clark Equipment Company To Establish West Coast Plant

Clark Equipment Company will establish a West Coast plant before the end of the year to be used first as a parts depot and expanded later as an assembly plant for fork lift trucks. To be located in the San Francisco-Bay area, the new plant will warehouse complete stocks of service parts for Clark and Clark-Ross industrial trucks and straddle carriers and for "Michigan" tractor shovels and excavator cranes.

Cooper-Bessemer Assigns Campbell to Houston Office

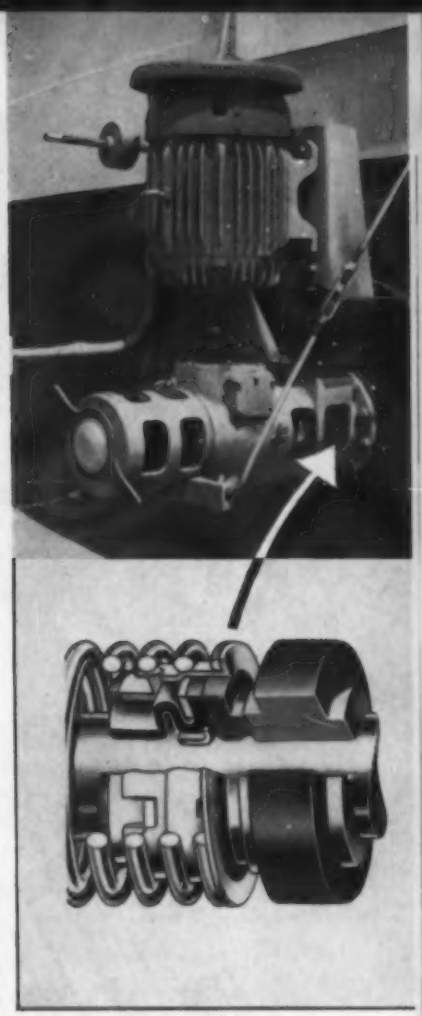
S. N. Campbell, recently assigned to the Houston office of Cooper-Bessemer Corporation, will handle engineering and sales of centrifugal, motor and engine-driven compressors for pipe lines, refineries, petrochemical and industrial plants in the Houston area. Campbell formerly served in the compressor engineering section at the company's headquarters plant in Mount Vernon, Ohio.

Graver Water Conditioning Appoints New Representative

Graver Water Conditioning Company, New York, has announced the appointment of the Edward G. Moninger Company as Graver's representatives in Minnesota, North Dakota, South Dakota and northwestern Wisconsin.

The Moninger Company, located at 504 Plymouth building, Minneapolis, will handle Graver's complete line of industrial and municipal water treatment and industrial waste treatment equipment.

REMOVABLE SEAL CARTRIDGE is a complete unit assembly, easy to stock as a replacement, or quickly obtainable in all sizes and materials, for the simplest or most difficult operating conditions.



YOU CAN REPLACE A LIGHTNIN rotary seal in a few minutes—without special skill, without draining the tank or dismantling the mixer, without losing a pint of product. Seal is shown here without housing, to illustrate components.

Newest cost-saver in side entering mixers:

End stuffing box repacking . . . forever

with a rotary seal that's easy to replace

Now you can enjoy the solid maintenance savings of leakproof rotary sealing in a side entering mixer—without the headaches seal replacement *used* to cause.

For here, at last, is a rotary seal that runs *years* without adjustment—yet can be replaced *in a few minutes* when necessary, without draining the tank or dismantling the mixer, and *without need for special skills.*

Here's what you gain when you specify LIGHTNIN Mixers with new LIGHTNIN Seals:

1. You end leakage—for good. The seal positively will not leak during its operating life.
2. You *eliminate* the cost of repacking stuffing boxes. The LIGHTNIN Seal takes the place of a stuffing box. Under most conditions, it runs smoothly for *years* without changing.
3. You stop costly "nursing" of stuffing boxes. The seal *never* needs adjustment.
4. And most important (because it's never been possible before)—you can replace a LIGHTNIN Seal *in a few minutes,* should it ever become necessary. Only one simple *cartridge* component to remove and replace—and you're back in operation. So simple, anyone who can handle a wrench can do the replacement job *in minutes.*

Already, many oil companies are using LIGHTNIN Seals. Users report savings running into many thousands of dollars per year. Your LIGHTNIN Mixer representative can give you the full story—show you how much *you* can save. Call him today. Or get the facts by mail: Send the coupon for 8-page, fully illustrated bulletin.

Get the cost-cutting facts now... New 8-page Bulletin B-111 shows how you get maintenance-free sealing that really slashes fluid mixing cost to a new low. Send also for LIGHTNIN Mixer catalogs listed here. Free—no obligation. Just check data you want, tear out and mail to us today with your name and company address.

- ☐ B-111 LIGHTNIN Rotary Mechanical Seals
- ☐ DH-50 and DH-51 Laboratory Mixers
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller types)
- ☐ B-104 Side Entering Mixers
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air-driven)
- ☐ B-110 Condensed Catalog (complete line)

MIXING EQUIPMENT Co., Inc., 196-m Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

Lightnin® Mixers

MIXCO fluid mixing specialists

3 RIGHTS THAT RIGHT ONE WRONG

The *right* gasket for the *right* flange for the *right* seal. This has been a controlling engineering principle at Flexitallic for 43 years. Engineers know that each Flexitallic Spiral-Wound Gasket is *specifically designed* to do its particular job.

Such definitive application is one of the important reasons why the Flexitallic Gasket finds wider and wider use in extreme or hazardous service — aboard ship, in power plants, aviation, the process industries, atomic research.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O.D.

FLEXITALLIC GASKET CO.
8th & Bailey Sts., Camden 1, N. J.
Representatives in principal cities

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

TEFLON FOR PROCESS APPLICATIONS

The ideal seal for many process applications is a Flexitallic Gasket with Teflon trapped between edges of stainless steel. Ask for folder, "Teflon in Flexitallic Gaskets."

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.

Thompson Heads New Office Of Gulf Publishing Company

Gulf Publishing Company of Houston announces the opening of a North Texas district office. Ed Thompson has been appointed district manager and will office at Room 518, Second Unit, Santa Fe building, Dallas.

Ed Thompson

Thompson has had extensive experience in the advertising selling field, formerly being employed by the Texas Harte-Hanks Newspapers. Before that he was connected with the Abilene Reporter-News.

Gulf publishes five specialized oil industry publications—PETROLEUM REFINER, THE REFINERY CATALOG, WORLD OIL, PIPE LINE INDUSTRY and THE COMPOSITE CATALOG. Thompson will concentrate most of his efforts on the last named three publications, but will be available for consultation also on problems concerning refining industry advertising and cataloging.

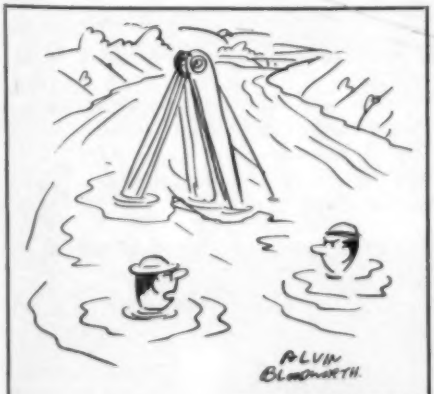
Southern Engine and Pump Has New Advertising Manager

Southern Engine and Pump Company has announced the appointment of S. Gerald Fuex as manager of sales promotion and advertising. Fuex formerly served as director of public relations and advertising for Trans-Texas Airways.

Westinghouse Names Berry To Aviation Gas Turbine Post

D. W. Berry has been appointed assistant chief engineer for the Westinghouse Electric Corporation's aviation gas turbine division, Kansas City, Mo. In this new post, Berry will be responsible for the over-all administration of the Engineering department, with emphasis on design and productibility aspects of jet engine work.

Berry was engaged in design and development problems in the Engineering department of the Wright Aeronautical Corporation 16 years. From 1952 to 1954 he was assistant chief product engineer for the J57 engines produced by Ford Motor Company in Chicago. He joined Westinghouse in 1954.



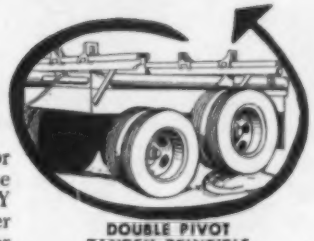
PIPE LINE INDUSTRY

"The old man swears by the map that we ain't at the river yet."

TOP QUALITY PIPELINE TRAILER

THE LOADCRAFT

PIPELINER



DOUBLE PIVOT TANDEM PRINCIPLE

At last here's a top-quality tandem trailer for the pipeline industry that is really built to take the cross-country hikes. The axles will STAY in alignment. Quality that has made Spencer Trailers popular with the oil fraternity for over 38 years goes into each of these jobs.

Double pivot tandem keeps load in balance in rough terrain, reduces wear and tear on axles and tires Hi-tensile pressed steel frame, wood surface block-type bolster plus other exclusive features gives you the kind of trailer you have needed ..and at a price that is less than you would expect to pay for such high quality.

Spencer-Safford LOADCRAFT
AUGUSTA, KANSAS

Please send me information on your
Pipeliner___ Pole Trailer___ Oil Field Float___
NAME_____
ADDRESS_____
TOWN_____STATE_____

More comments on this new Handbook:

"... a most practical on-the-job manual for men concerned with pipe line corrosion. We are ordering copies for each of our district engineers."

Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This Handbook, written by Marshall E. Parker, consultant, is designed as a practical field manual. It is a 108-page pocket-size volume printed first as a popular series in WORLD OIL. The Handbook is illustrated with many charts and drawings and is completely indexed by subjects.

It presents comprehensive data on Soil Resistivity Surveys, Potential Surveys, Line Currents, Current Requirements, Rectifier Systems, Ground Bed Design, Magnesium Anodes, Stray Current Electrolysis, Interference in Protective Systems, Operations and Maintenance, and Coating Protection and Testing.

An appendix has been added of technical data on Underground Corrosion, Basic Principles of Cathodic Protection, Properties of Metals and Attenuation Equations. Order copies of this practical Field Manual now for each of your field men. Price $3.

Send for your FREE copy of the New Petroleum Book Catalog which describes the nature and contents of many books pertaining to the Petroleum Industry.

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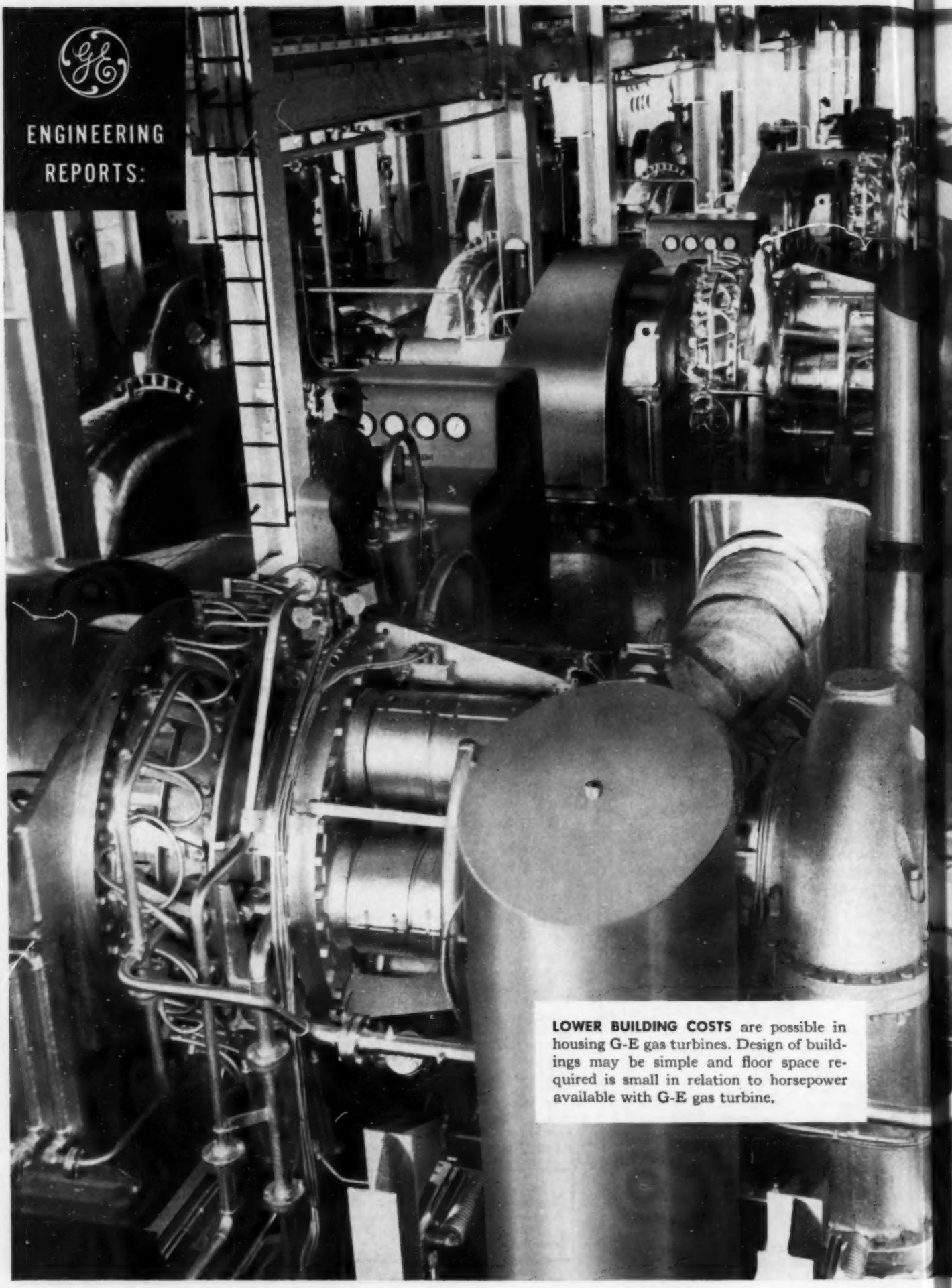

ENGINEERING
REPORTS:
LOWER BUILDING COSTS are possible in housing G-E gas turbines. Design of buildings may be simple and floor space required is small in relation to horsepower available with G-E gas turbine.

41 G-E GAS TURBINES now operating in gas pipeline industry have proved to be economical power sources.

8 G-E gas turbines for Northern Natural Gas give up to

25% MORE HP FOR PEAK LOADS

A total of eight 5700-hp General Electric gas turbines are now in operation at the Tescott and Macksville compressor stations of Northern Natural Gas Company in Kansas.

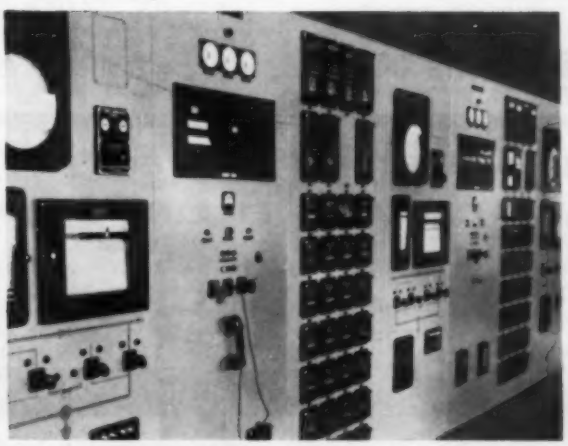
These complete, economical prime movers have this fundamental characteristic: horsepower increases as ambient temperature decreases. Thus, during cold weather, when demand is greatest, up to 25% more power may be delivered.

Proven economies of operation and maintenance explain why many natural gas pipeline stations are being planned for G-E gas turbines. Have you investigated their many advantages?

For more information, contact your nearest G-E Apparatus Sales representative, or write for information bulletin GEA-5962 to General Electric Company, Section 661-52, Schenectady 5, New York.

Combustion Gas Turbines for the Gas Pipeline Industry—Backed by over 50 years of Turbine Leadership

GENERAL ELECTRIC



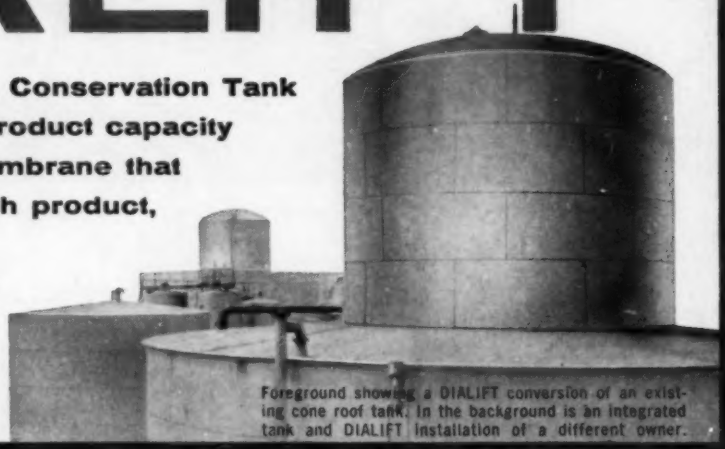
COMPLETE STATION CONTROL is handled from the four combined process-control and turbine-control panels. After preliminary manual operations, turbine comes to speed automatically.

COMPACT, FACTORY-ASSEMBLED, low-voltage switchgear, Cabinetrol* panel at Tescott station were planned by General Electric to take a minimum of space and to meet the station's individual requirements.

*Registered trade-mark, General Electric Co.

The HAMMOND DIALIFT

The ONLY membrane type Conservation Tank with full-rated vapor and product capacity AT ALL TIMES, with a membrane that cannot come in contact with product, vapor space that can be isolated for inspection and maintenance without taking product storage tank out of service.



Foreground showing a DIALIFT conversion of an existing cone roof tank. In the background is an integrated tank and DIALIFT installation of a different owner.

Principle of the Hammond Dialift

A— DIALIFT DIAPHRAGM rises and falls to accommodate expanding and contracting vapor.

B— Vapor passes to and from tank and DIALIFT through simple elbow connection.

C— DIALIFT and tank have full-rated capacity.

D— Membrane can't come in contact with product.

E— DIALIFT can be isolated for maintenance and inspection, product tank stays in service.

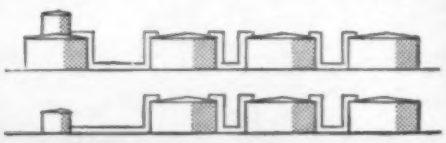
The most efficient and economical vapor conservation system for new or old tanks.

THE HAMMOND DIALIFT consists of a gas-tight Vulcalock membrane attached to the inside periphery of a cylindrical metal housing to become a "breathing" apparatus to accommodate the expanding and contracting vapor as developed in product storage tanks. The DIALIFT can be used as a single conservation unit by being attached to the roof of a product storage tank or as a central "breathing" system by being manifolded to a number of product storage tanks. There are two forms of installation: —Ground type manifolded to a number of tanks to form a conservation system and integrated type whereby the DIALIFT is attached to the roof of a product tank for vapor conservation for one or a number of tanks.

The DIALIFT is completely isolated from the product storage tank. Vapor passes between the tank and DIALIFT through a vaporline connection. It is easy to convert old cone roof tanks to efficient vapor-saving DIALIFT installations by attaching a DIALIFT housing with membrane to the roof of the old tank and connecting the vaporline between the tank and DIALIFT.

New or converted DIALIFT tank, inter-connected with cone-roof tanks, becomes central "breathing" unit.

DIALIFT GROUND UNIT serves as central "breathing" apparatus of multi-tank conservation system.



THE HAMMOND DIALIFT ELIMINATES BREATHING LOSS AND REDUCES FILLING LOSS

Write for catalog 55DL

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R. F. Orth

T. R. Turnbull

G. R. R. Wahl

J. H. Goodwin

Three Johns-Manville Divisions Created; New Managers Named

Johns-Manville will split its present Industrial Products division into three new operating divisions, the Pipe division, Packings and Friction Materials division and Industrial Insulations division.

General manager of the Pipe division will be Robert F. Orth who also has been elected vice president of Johns-Manville Sales Corporation. Orth has been manager of the J-M Transite Pipe department since 1946. Other division general managers named are Francis J. Wakem, Industrial Packings and Friction Materials, and Don L. Hinmon, Industrial Insulations.

Orth's staff for the new Pipe division will include T. R. Turnbull, production manager, who has been elected vice president of Johns-Manville Products Corporation, and George R. R. Wahl, merchandise manager, and John H. Goodwin, general sales manager, who have been elected vice presidents of Johns-Manville Sales Corporation.

The expansion in organization, which becomes effective January 1, 1956, continues the decentralization of operations started in 1946 and backed by a continuing plant and mine expansion program in which about $20 million has been invested each year since the end of World War II.

Raytheon Manufacturing Reorganizes District Offices

A reorganization of sales and service districts of Raytheon Manufacturing Company's equipment marketing division recently was announced. This reorganization establishes three new sales and service districts with headquarters in Baltimore, Atlanta and Kansas City, Kansas. Headquarters for other sales and service districts are in Boston, New York, New Orleans, Cleveland, Chicago, Seattle and Los Angeles.

Managers for the three new districts will be Roger Mackay, Atlanta; Edward Keesler, Baltimore; and W. J. Monroe, Kansas City. Other new district manager appointments include Joseph C. Profita, Chicago; Emile J. Rome, New Orleans, and Howard H. Ganson, Jr., Seattle.

Moffitt and Lang Receive U. S. Steel Executive Promotions

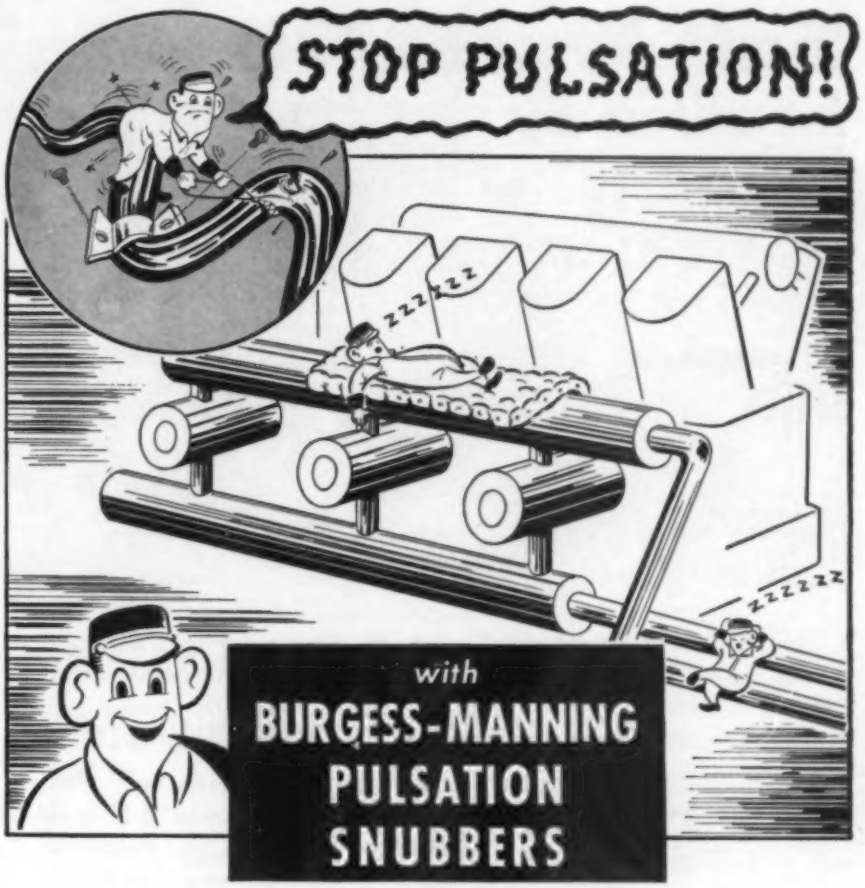
Ralph C. Moffitt, new assistant vice president and director of purchases of United States Steel Corporation, will retain his present responsibilities and assume those of R. L. Van Cleve, assistant vice president—purchases, who is retiring after 41 years with the company.

Moffitt joined U. S. Steel in the Purchasing department of the Columbia Steel Company and, in 1947, was appointed assistant vice president—purchases of the U. S. Steel Corporation of Delaware. Named director of purchases of U. S. Steel Company in 1951, he became director of purchases of the U. S. Steel Corporation two years later.

William H. Lang, recently appointed assistant vice president, U. S. Steel Corporation, will continue in his present position as assistant treasurer of the corporation and president, U. S. Steel Homes Credit Corporation, in addition to his new position.

Byron Jackson Names Rumery Head of Business Development

Byron Jackson Division of Borg-Warner is expanding its business development and has appointed John W. Rumery to head its increased activities. In his new position, Rumery will seek industrial investment opportunities for Byron Jackson in the Los Angeles area. For the past several years, he has been in the investment management business in Southern California.



Burgess-Manning Pulsation Snubbers will remove one of your most aggravating and costly bug-a-boos, that of line surges from compressors, pumps, blowers, etc. Maintenance and service costs will drop sharply — lines and associated equipment will operate at a new efficiency — flow control can be greatly improved. Structural supports of pipe lines need no longer be of costly and special construction — gas compressors and pumps will deliver full design flow with greatest efficiency in pulse-free piping.

Send us your specifications for recommendations

BURGESS-MANNING COMPANY

Sound Engineering

713 East Park Avenue, Libertyville, Illinois

Dallas, Texas

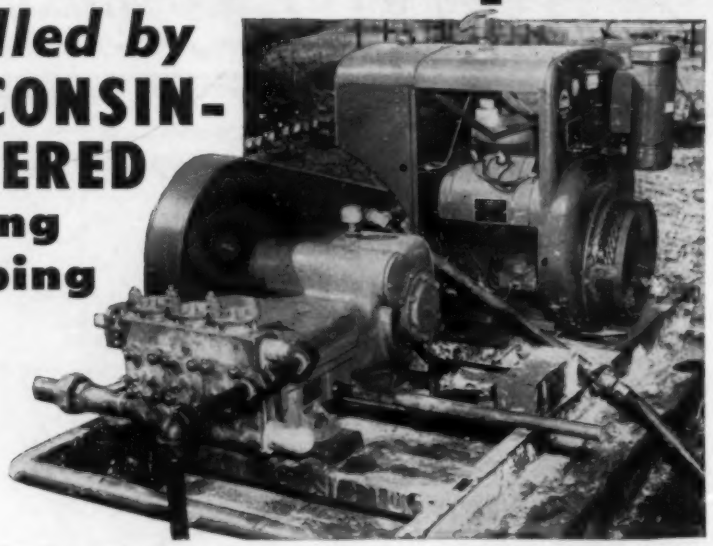
New Books, Maps and Movies

FINAL REPORT ON FOUR ANODE INSPECTIONS AT GROUND BEDS INSTALLED BY MISSISSIPPI POWER AND LIGHT COMPANY FOR COMMITTEE TEST PROGRAM, National Association of Corrosion Engineers, 1061 M & M Building, Houston 2.

The report, to be published soon, is on the performance of anodes for impressed currents tested for four years in soils. Carbon, graphite and steel anodes were tested in natural soils and carbonaceous backfill. Positive results were obtained in the tests and variations in performance are great enough to permit deductions concerning anode performance under similar conditions of installation. Details concerning ground bed construction were included in NACE Publication 50-1.

Prepared by Technical Unit Committee T-2B on Anodes for Impressed Currents, the report also includes recommendations on anode type, ground bed sites, backfill and installation methods. Tables show anode current and net anode resistance for the four-year test period.

Salt Water Disposal
handled by
WISCONSIN-POWERED
Deming Pumping Unit



The problem of getting rid of salt water after it has been separated from the oil, without polluting surrounding land, streams or endangering livestock, has been successfully solved with this heavy-duty pumping unit.

This specially designed pump, made of special materials, best suited to this type of operation, will handle 1200 barrels of oil field brine per day at 1,000 lbs. pressure, forcing the water back into the porous formation. This unit is being used by leading oil producers and is giving a very good account of itself, according to reports from the field.

A heavy-duty V-type 4-cylinder Wisconsin Air-Cooled Engine provides the steady-going, completely dependable power that keeps the pumping unit going day in and day out, with an absolute minimum of human attention and servicing. Tapered roller bearings at both ends of the crankshaft carry the load smoothly and provide fullest protection against bearing failure. Extremely efficient AIR-COOLING solves the cooling problem under all weather conditions, from sub-zero to 140° F.

You can't do better than to specify WISCONSIN ENGINE POWER for *your* oil field equipment.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

A 8418-½1

OIL AND GAS PIPE LINES IN OHIO, Revised Edition, 1955, Division of Geological Survey, The Ohio State University, Columbus 10, Ohio. $1.50 for folded map.

This new map, in five colors, shows operations of the oil and gas industry in Ohio. The gas portion contains names of utility companies, size, number and ownership of transmission lines, number of consumers, points of distribution, compressor stations, underground gas storage areas and gas lines entering the state. The oil section includes location of refineries, their capacity, principal refined products, crude and products transmission lines, direction of flow, compressor stations and large storage terminals.

•

CONSTRUCTION PRACTICES FOR OIL AND PRODUCTS PIPE LINES, Division of Transportation, American Petroleum Institute, 50 West 50th Street, New York 20. $1.50.

The bulletin, which resulted from the combined work and judgment of a representative group of pipeliners, presents recommendations designed to improve specification and contract practices in the construction of pipe lines.

The bulletin is divided in sections. Part I covers various methods of construction to show why certain specifications and contract clauses are needed. Part II contains sample specifications that may be followed or modified to meet special circumstances. Part III contains sample contract clauses that may be useful in meeting individual requirements. The general conditions in Part IV cover recommended contract terms that might be contained in most agreements.

•

GAS FACTS, Bureau of Statistics, American Gas Association, 420 Lexington Avenue, New York 17. $2.

The 1955 edition of the annual statistical yearbook of the American Gas Association contains 1954 statistics on the gas utility and pipe line industry, including information on energy reserves, production, transmission and distribution, underground storage, sales and utilization, finance, labor, prices and a brief section of Canadian statistics.

Features not included in earlier editions are a separate income statement and balance sheet for pipe line companies from 1941 to 1954; additional statistics on exploratory drilling for natural gas and/or oil; detailed tables showing appliance shipments, and tables showing, for selected cities, cost of residential heating fuels since 1941, with suggested fuel efficiency factors.

•

THE GAS DATA BOOK, Bureau of Statistics, American Gas Association, 420 Lexington Avenue, New York 17. 50 Cents.

A condensed summary of gas industry statistics, this pocket-sized publication is intended for easy reference to basic gas industry facts. Containing historical information on the principal measures of industry growth, the booklet provides a convenient summary of the more detailed information contained in "Gas Facts."

Cut maintenance costs. . . increase pipe life

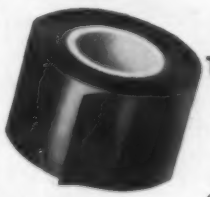
with proven performance...

Johns-Manville Pipe Protection Materials

On job after job, pipe line men rely on these three Johns-Manville products to fight pipe line corrosion:

Transhield Asbestos Felt—This low-cost pipe line protecting wrapper is specially designed to increase pipe life under average soil conditions. It is reinforced with continuous glass yarns, parallel spaced on ¼" centers to give tear-free application strength. Made of coal-tar saturated asbestos, it acts as a continuous barrier to shield pipe line enamels from earth loads and soil stresses.

#15 Asbestos Pipe Line Felt—A heavy-duty material particularly suitable for severe soil conditions or where a heavier material than J-M Transhield is desired. Provides long life, toughness, flexibility, resistance to rot, decay, cracking, and impact. J-M #15 Asbestos Felt now protects more than 100,000 miles of oil and gas pipe lines. Widths 2" to 36". Rolls any length desired.



Trantex® Polyvinyl Tape—A widely used coating where ease of application is important . . . over field-welded joints of mill-wrapped pipe . . . for rush coating needs. Pressure-sensitive . . . sticks to pipe on contact, forming a firm, stable bond. Can be cold-applied by hand or with simple wrapping machines. In rocky soils, an outer wrap of J-M Transhield or J-M #15 Asbestos Pipe Line Felt is recommended.

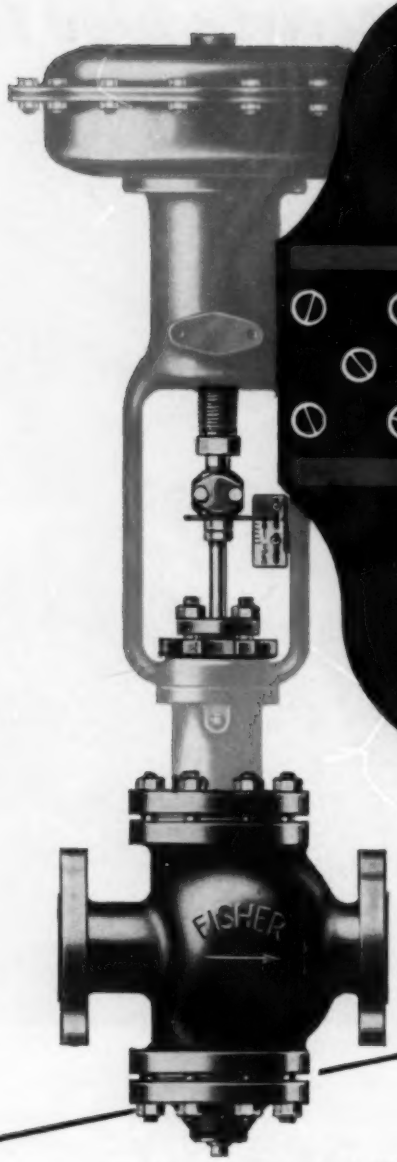
For further information about Johns-Manville Products for Pipe Line Protection, write to Johns-Manville, Box 60, New York 16, N. Y.; in Canada, Port Credit, Ontario.

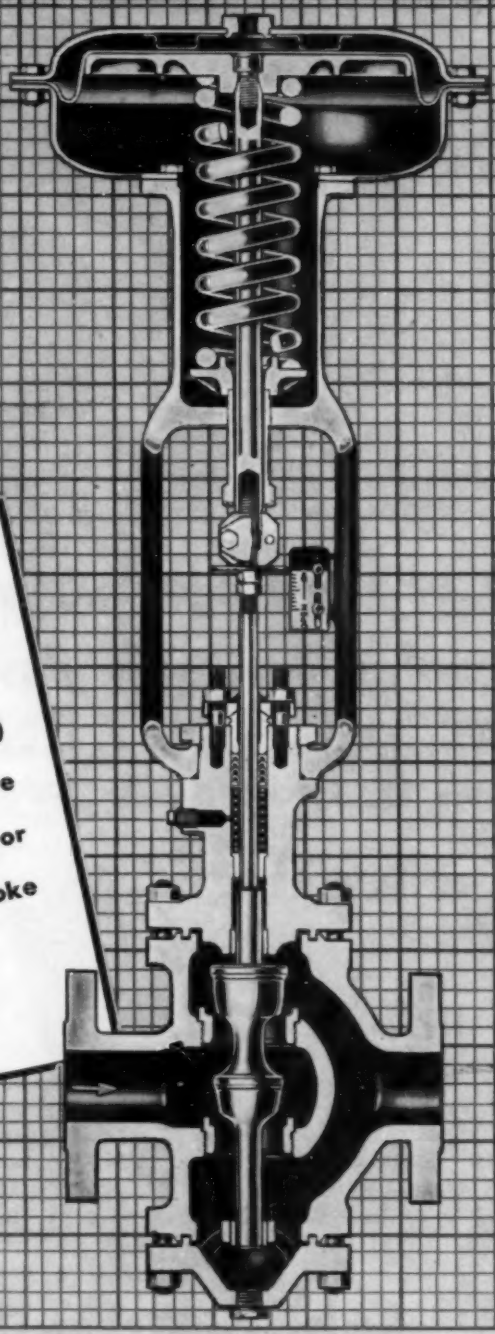
JOHNS-MANVILLE JM PRODUCTS **Johns-Manville** **PRODUCTS FOR PIPE LINE PROTECTION**

For more data on advertised products, use Readers' Service Cards, last page.

FISHER®

DIAPHRAGM





Fisher Diaphragm Motor Valves are furnished in a wide variety of pressure ratings and materials. Topworks may be either direct acting (Series 657) or reverse acting (Series 667). Handjacks are available for either diaphragm casing mounting or yoke mounting. There are six diaphragm and yoke size combinations.

Improved MOTOR VALVES

Improved PERFORMANCE FEATURES

- Bolted-clamp type stem connection allows stem adjustment of 50% of total travel. Can be disconnected in the field without stem damage. Will not shake loose from vibration or rotational inner valve forces.

- Rugged body to yoke connection with hammer leg nut. Topwork can be removed without disturbing stuffing box.

- Specially designed Buna N molded diaphragms with Nylon insert retain superior flexibility at low ambient operating temperatures. Provides linearity between operating pressure signal and travel, and gives maximum effective area.

- Bolted gland stuffing box with Teflon packing.

- Stainless steel clear view travel indicator.

- Spring ranges: 3 to 15 psi; 6 to 30 psi.

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

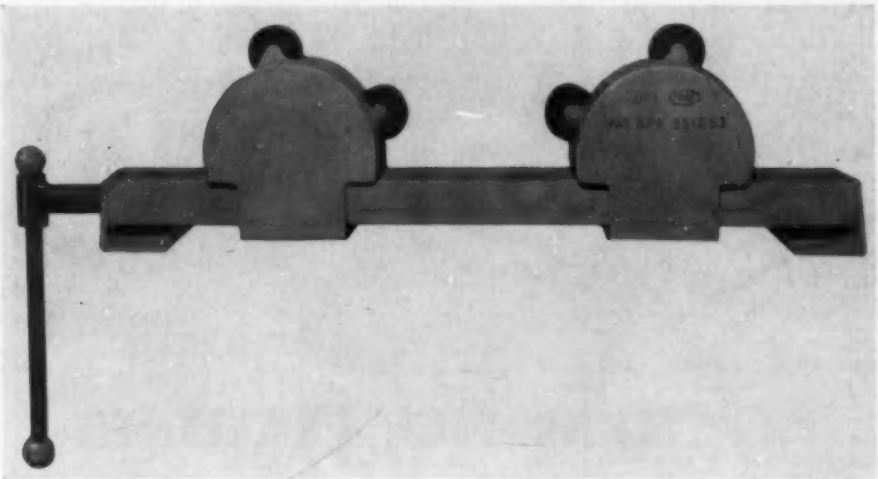
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER

Our 75th ANNIVERSARY

What's New in Equipment

for the Pipe Line Industry



Pipe Dolly

A new combination pipe dolly which reduces pipe handling time up to 85 percent has been added to the line of products manufactured by the H&M Pipe Beveling Machine Company of Tulsa. The dolly, designed for simplicity of operation and maximum accuracy, provides for adjusting pipe over a variation of several inches.

Use of the dolly involves setting the traveling heads in a partially closed position, loading the pipe in the dolly, checking the level and rotating the adjustment handle to lower or raise the pipe until it is leveled. Rollers permit rotating for either manual or automatic welding.

In addition to leveling and rolling, the dolly can be used to align pipe. It handles all pipe sizes through 36 inches and is ruggedly constructed to handle a load capacity of 2500 pounds.

For more data circle **No. E1** on Readers' Service Card, last page this issue.

Blacktop Coating

Meco "Black Knight" Surface Sealer, a pitch emulsion that is insoluble in oils and gasoline, can be quickly applied, and improves and protects the surface of blacktop paving, has been developed by Maintenance Engineering Company. The product prevents softening and disintegration of bituminous concrete from attack by oils, greases, gasoline and weather.

With the protective sealer, now available in charcoal, red or green color, new blacktop can be improved in appearance and durability, and old blacktop paving can be made to appear new as the coating fills cracks, checks, depressions and small holes. On exterior paving, the sealer prevents cracking, heaving and breaks due to penetration of water, softening of the base or disintegration due to freezing.

The sealer makes blacktop easy to keep clean by brushing or hosing; and it can be applied quickly and simply by machine or manually by brush. It is applied to a wet surface as it comes in the container, and it dries in a few hours.

(This item supplements Maintenance Engineering Corporation data on Pages 2997-3000 of the Composite Catalog, 20th Edition.)

For more data circle **No. E2** on Readers' Service Card, last page this issue.

Microwave

Microwave equipment which provides maximum circuit continuity has been announced by Motorola Communications and Electronics, Inc. Two simultaneous beams at different frequencies are transmitted to a distant station. The same information is impressed on both beams, and the receiver automatically selects the better received signal.

Two separate transmitters on different frequencies are used to transmit the two beams. The two signals are detected by two separate receivers at the distant station, but the output of only one receiver is used. The switching between receiver outputs requires only a few milliseconds and is unnoticeable on a voice circuit.

Equipment is available for locally-controlled indoor or remotely-controlled outdoor installation. Microwave transmitter and receiver units are packaged in plug-in boxes for fast, efficient maintenance. A single antenna system transmits both beams. Tower-mounted reflectors provide extra height for "line of sight" transmission. Equipment remains on the ground for easy servicing, and transmission lines up the tower are eliminated. Sensing circuits detect any abnormal equipment condition, switch receiver outputs accordingly and actuate an alarm indicating the nature of the trouble.

For more data circle **No. E3** on Readers' Service Card, last page this issue.

Telemeter System

United Engineers, Inc. new model telemeter system is a simple, stable receiver-transmitter set for transmission of operational data or control signals along a telephone line. The system operates on the principle of pulse rate, carrier-modulation with the input signal to the transmitter derived from a variable resistance. The output signal from the receiver is an electrical signal for the operation of conventional recorders and/or control devices.

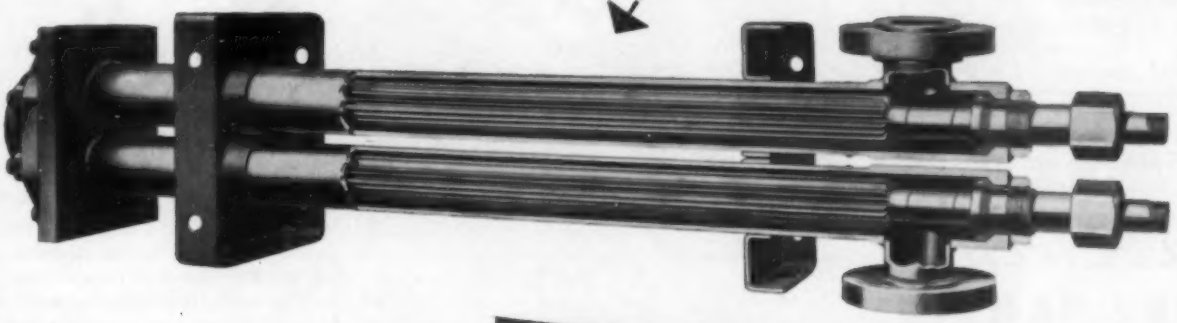
The system has been designed to operate with resistance transducers which translate such parameters as motion, pressure, temperature, acceleration, position and strain as a resistive change at their output terminals. In general, the data transducer has the form of a mechanically-operated potentiometer. Addition of a potentiometer to the pen drive mechanism of a remote recorder duplicates or repeats the data at a centrally-located control station.

Two sets of the system may be connected in a bi-directional installation to produce a long-distance feedback loop for remote control and automatic operation. Operational distance is limited only by the characteristics of the inter-connecting transmission system between the transmitter and receiver.

For more data circle **No. E4** on Readers' Service Card, last page this issue.

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue.

70,000



Unmatched Simplicity:

The simplest heat exchanger on the market. *Simple design*—no tube sheets, baffles and internal joints. *Simple installation*—easily stacked and connected in series or parallel. *Simple maintenance*—no stuffing boxes, no rolled tube joints, no gaskets. Simple and effective shell end-closure.

Unmatched Versatility:

Readily converted from one service to another. Can be used for practically any condensing, cooling, heating or heat exchanger service. G-Fin elements and fins available in any ferrous or non-ferrous metal best suited to your specific applications.

Over 70,000 G-R Salesmen on the job!

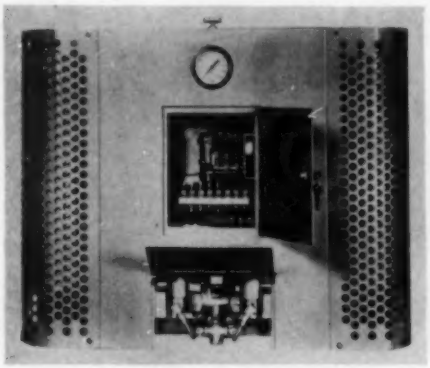
Are seventy thousand salesmen enough to persuade you that the G-R Twin G-Fin Section is a superlative unit? Seventy thousand is the number of trouble-free G-R Twin G-Fin installations made over a period of 20 years. Some of these installations have been operating continuously for the entire period—a record unmatched in the industry.

G-R
HEAT TRANSFER APPARATUS

THE GRISCOM-RUSSELL CO.
MASSILLON, OHIO
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

Twin G-Fin Section

GR 340



Midget Dryer

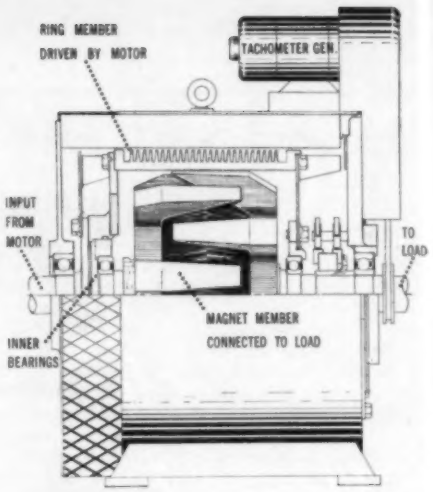
With the growing need for drying small volumes of compressed gasses to sub-zero dewpoints, Industrol Corporation announces the develop of a completely new solid desiccant type dynamic dehumidifier.

This Midget Dryer is offered in three sizes, all of the units being completely automatic, electrically regenerated and of compact design for wall or bench mounting. These units provide low cost, dependable drying for compressed gas systems in a wide variety of industrial and laboratory applications.

For more data circle No. E5 on Readers' Service Card, last page this issue.

Speed Drive

A precise adjustable speed drive for a wide field of applications has been developed by Electric Machinery Manufacturing Company. Easy to handle, install and operate, the new unit can be coupled or belted to an existing motor to provide a speed control of plus-or-minus two percent for fans, centrifugal pumps and compressors and, also, is designed to handle constant torque loads. With it, the user can operate a load at the optimum speed; can change speed smoothly by means of a knob or can control it automatically; can use the drive for test and development work; can control output of fans, pumps and compressors automatically and with a high degree of precision; can increase efficiency of fan and pump drives, decrease wear of moving parts and eliminate shocks between motor and load.



The system consists of the "Ampli-Speed" drive installed between the motor or other drive and the load, a wall-mounted magnetic amplified speed control and a control rheostat mounted at any convenient location.

The drive is designed for use with motor speeds of 870, 1150 and 1750 rpm. Horsepower ratings of the two sizes range up to 95 hp for fan-type loads. For constant torque loads, the output ranges up to 75 hp, depending upon input speed and required speed range.

For more data circle No. E6 on Readers' Service Card, last page this issue.

See Composite and Refinery Catalogs, or Write for Specifications Folder

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Nozzle sizes from ¼" to 24"

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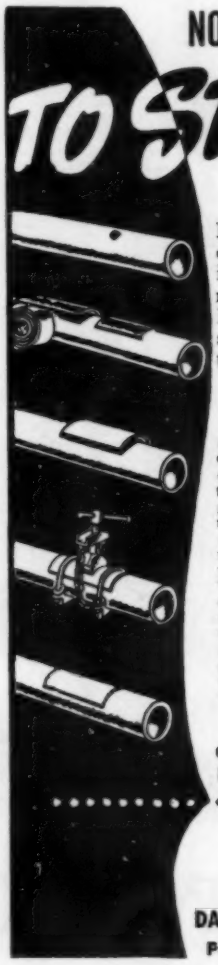

DALLAS GRO-CORD GASKETS now offer the complete pipe-line gasket service. Formerly up to 10", GRO-CORD'S new stock is now made UP TO 30 INCHES in two sections—flat and crown stock plied together to insure safe, extra-tight sealing.

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They Last for Years

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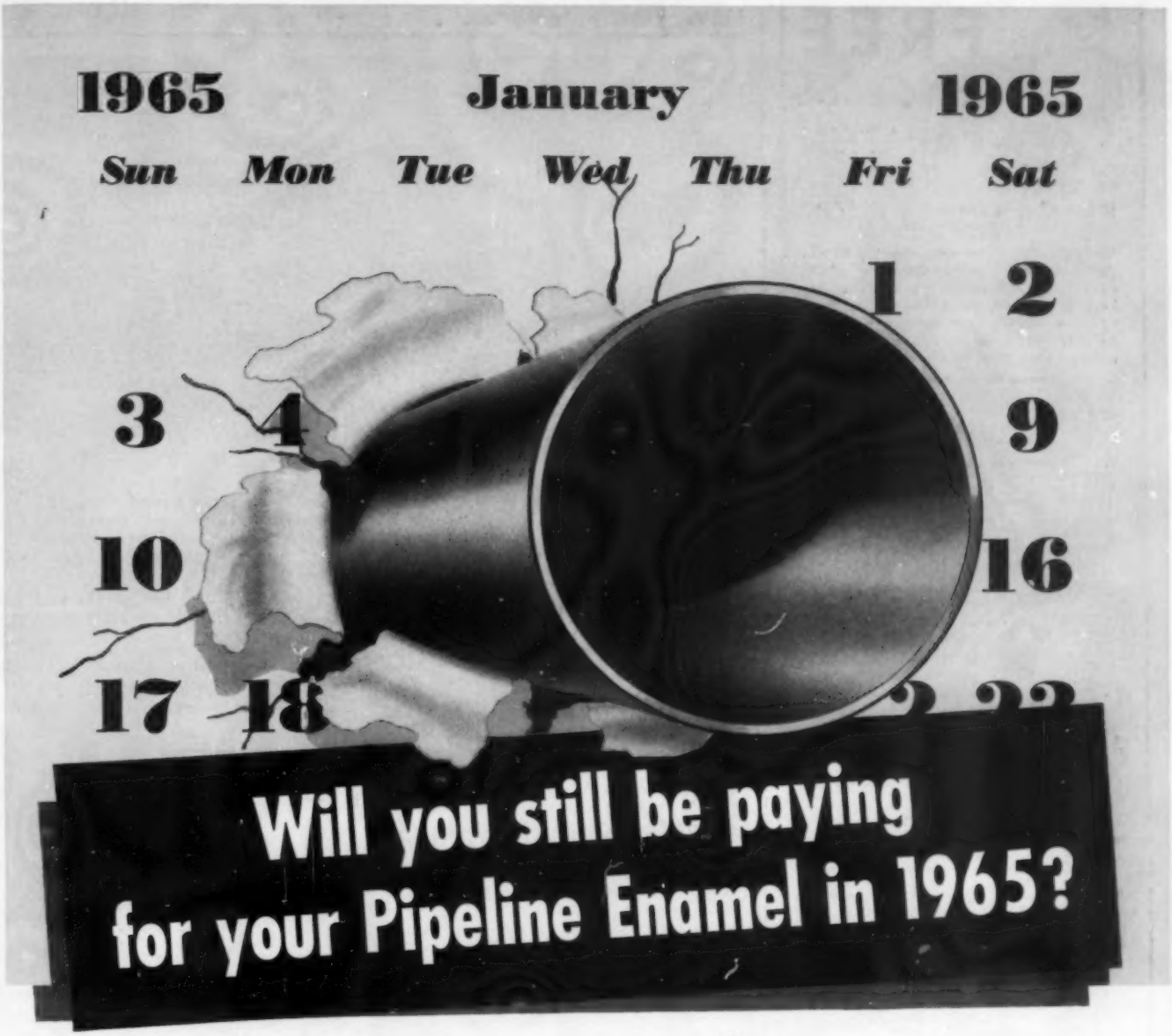

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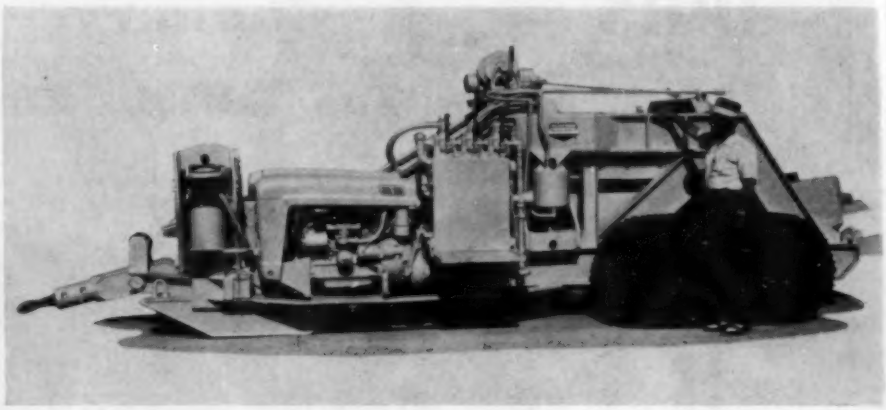
NEW EQUIPMENT . . .



Pipe Bending Machine

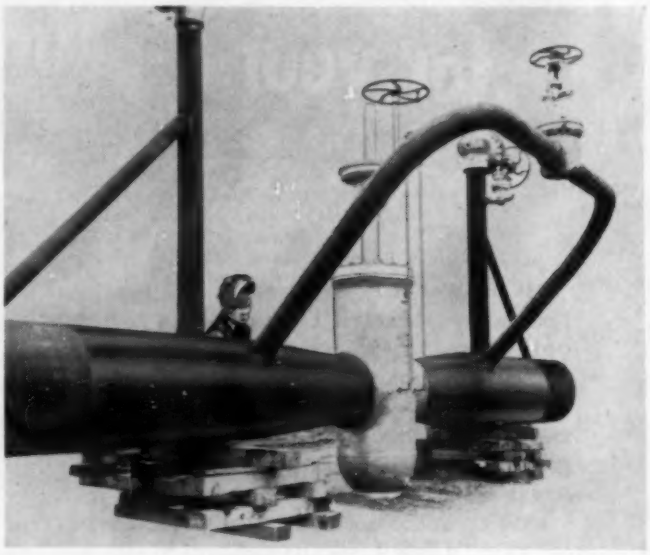
The first vertical pipe bending machine to utilize hydraulic action for making cold, smooth bends has been announced by Cinch Pipeline Equipment, Inc. Available in two sizes, 16 through 30 inches or 22 through 36 inches, the new pipe bender is lighter, faster and more compact than any other previously available handling large diameter pipe.

In use, it is reported that 122 bends were made on 36-inch pipe in one ten-hour day. Some bends were as much as 21 degrees in a 40-foot joint of pipe with wall thicknesses of .406 and .469.

The bender can be quickly and easily transported on a float trailer without removal of tracks.

For more data circle **No. E7** on Readers' Service Card, last page this issue.

Multiple Outlet Headers



Ladish Company has developed a special-purpose fitting which simplifies installation and effects a 70 percent saving in welding time required to complete by-pass, blow-down and branch connections to pipe line gate settings. It eliminates the practice of nozzling in branch connections and saddle reinforcements.

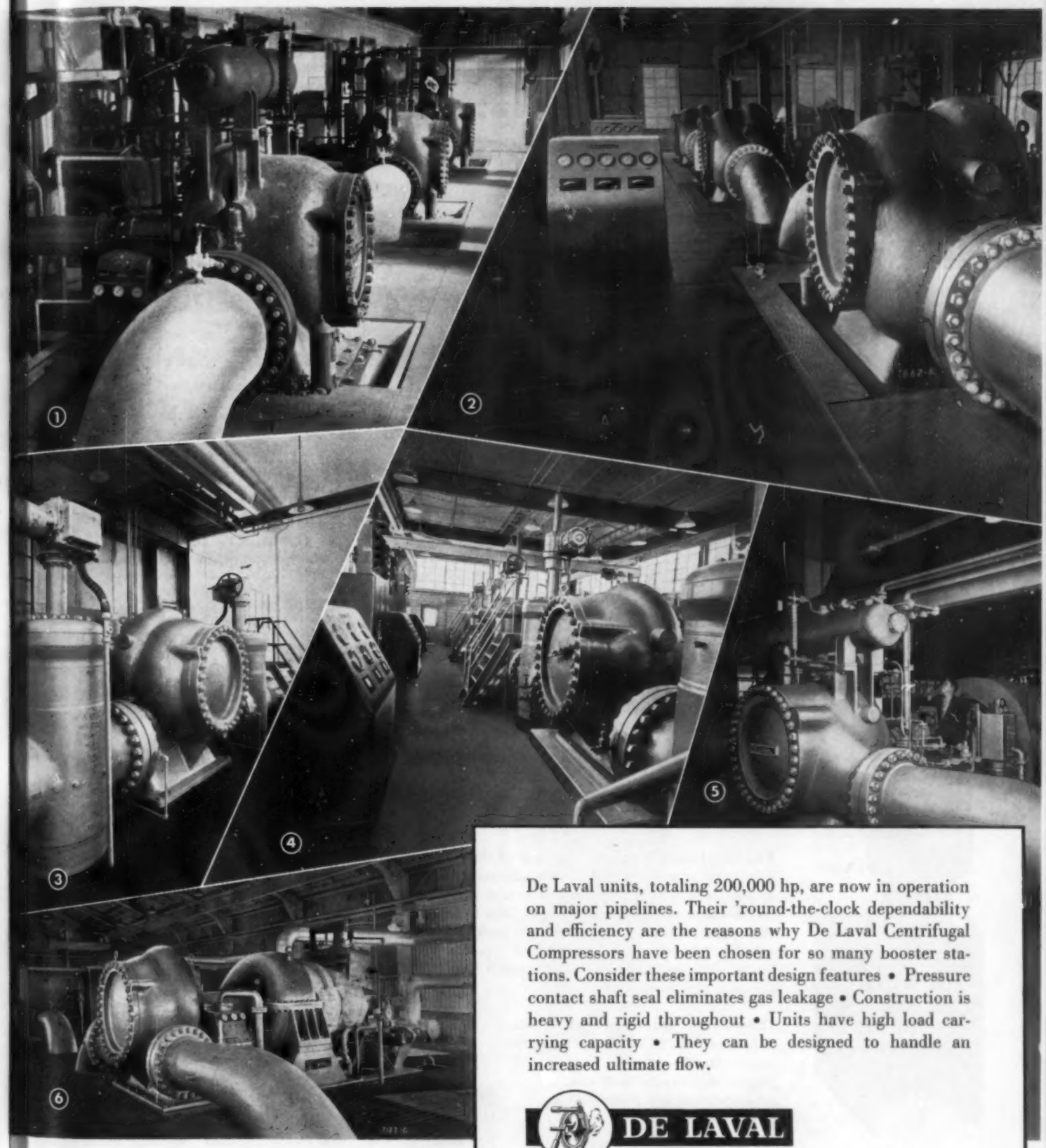
The fitting consists of a header with multiple seamless outlets in exact specified positions, plus a factory-fabricated conical reducer. Design and metallurgical integrity of Ladish headers provide strength superior to that of the piping to which it will be joined, provide additional resistance to stresses arising from thermal difference and external mechanical loads and provide maximum resistance to shock and vibration loads.

Basic outlet design of the header parallels integral outlet of seamless welding tees. Walls are formed from seamless pipe by forging process which directions metal grain flow, improves metal structure, distributes metal for increased strength and reduces flow turbulence by providing smooth transition between header and branch. Multiple outlet headers can be produced in sizes up through 42-inch pipe and larger. In addition to being used for valve settings on the main line, these headers also are being used as suction and discharge manifolds on compressors.

For more data circle **No. E8** on Readers' Service Card, last page this issue.

Circle numbers on Readers' Service Cards on last page

These pipelines depend on DE LAVAL *Centrifugal Compressors*



Located in booster stations of:

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2. *El Paso Natural Gas Company*
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6. *Transcontinental Gas Pipe Line Corporation*

De Laval units, totaling 200,000 hp, are now in operation on major pipelines. Their 'round-the-clock dependability and efficiency are the reasons why De Laval Centrifugal Compressors have been chosen for so many booster stations. Consider these important design features • Pressure contact shaft seal eliminates gas leakage • Construction is heavy and rigid throughout • Units have high load carrying capacity • They can be designed to handle an increased ultimate flow.

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Centrifugal Compressors

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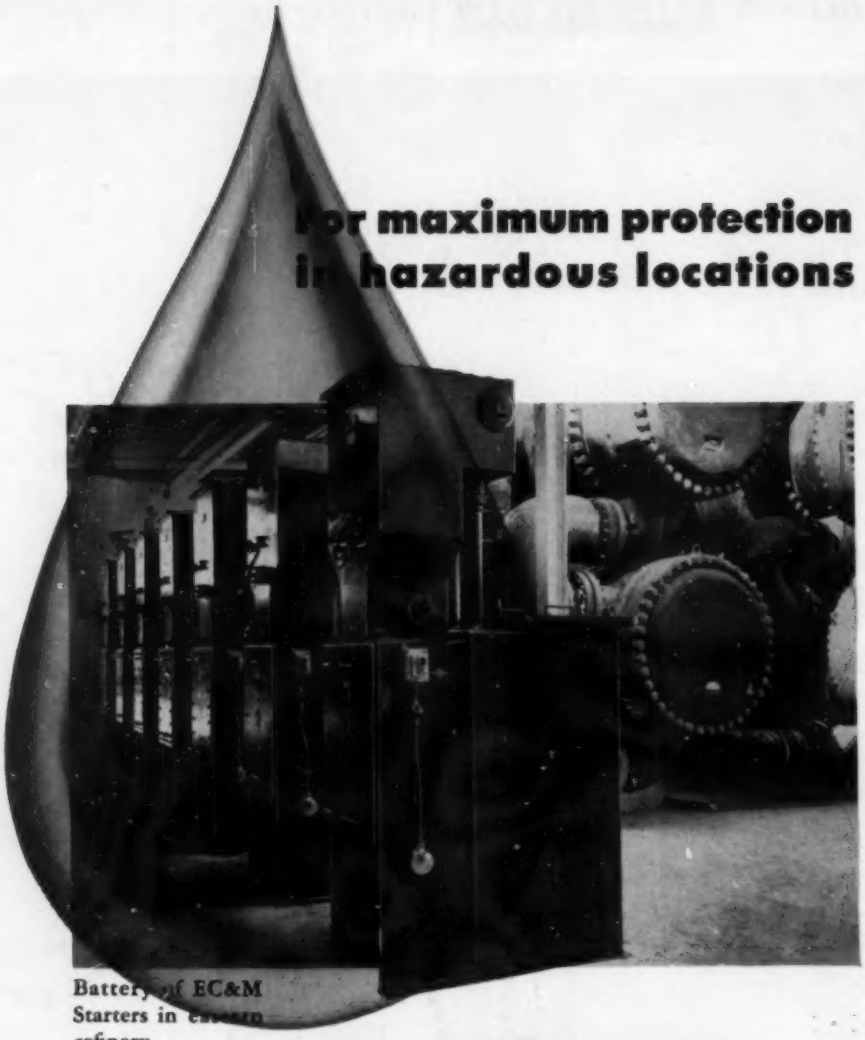
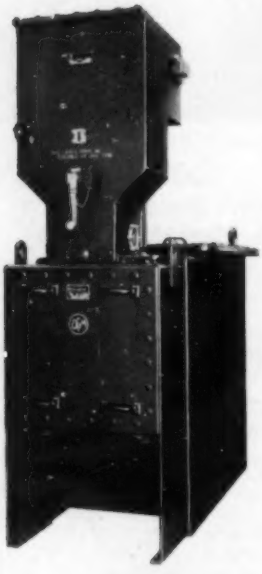


Battery of EC&M Starters in eastern refinery.

OIL-IMMERSED
50,000 KVA INTERRUPTING CAPACITY
MOTOR STARTERS BY EC&M



This installation is another example of the increasing acceptance of EC&M oil-immersed Motor Starters by refinery engineers and construction and design companies. The inherent advantages of these starters are high interrupting capacity (50,000 kva or VALIMITOR type for bus of unlimited kva) and assurance of a compact, neat installation.

These slender space-saving starters with self-contained Oil Disconnect Switch require less floor space . . . result in greater area around each unit for inspection and maintenance.

Write for illustrated 16-page Booklet 6062 for full details.

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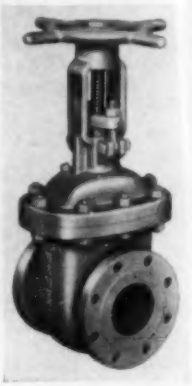
6078

NEW EQUIPMENT . . .

Gate Valve

An all-new gate valve which provides impenetrable line shut-off, both on the upstream and downstream side of the wedge, has been designed by Hamer Valves, Inc. In addition to the precision metal-to-metal contact of the wedge and valve body seats, the new Hamer gate valve incorporates a pair of Teflon packing seals which press dead-tight against the wedge, forming an impassable seal. Stainless steel locking rings and seats have made the valve impervious to corrosive fluids moving through the line.



Replaceable stainless steel seat is lightly welded into the valve body to insure against leak-through. Valve is easily serviced in the line when necessary.

For more data circle **No. E9** on Readers' Service Card, last page this issue.

Graphite Anode

A new concept in impressed-current cathodic protection has been developed by National Carbon Company, a division of Union Carbide and Carbon Corporation. The system comprises a new graphite anode, Type QA, and an assembly technique which fixes the anode on the cable exactly where it is needed.

The anodes are attached by crimp type connectors on sizes 4, 5 or 8, seven strand cable, at any desired spacing on long cables. They are available in standard 2- by 12-inch 2- by 20-inch and 3- by 30-inch sizes.

The anodes were developed for installation in cable ducts. In such applications, they are spaced to provide protection of metallic sheathed cables in adjacent ducts at relatively low current consumption. They also can be assembled at any desired spacing on long cables installed in ditches to protect paralleling bare pipe runs. When bedded in carbonaceous backfill, the new anode shows costs comparable with larger graphite anodes plus greater flexibility in installation and generally lower circuit resistance per ampere capacity.

Advantages include virtually no limitation to size, type or length of cable, lowest circuit resistance per dollar installed cost, optimum anode distribution at minimum cost, light and easy handling, no damage or breakage in shipping, high assembly strength and electrical connection at center of anode.

For more data circle **No. E10** on Readers' Service Card, last page this issue.

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Keep 'Em Cool!

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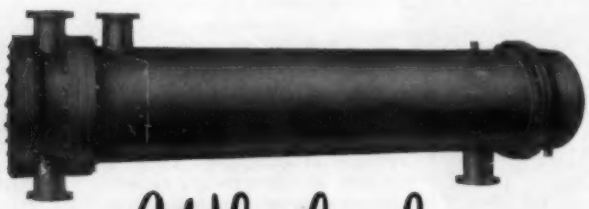
The cooler is two-pass in design and properly baffled to develop high fluid velocities and subsequent high heat transfer rates, with minimum pressure drop. Its non-ferrous tube bundle, cast iron channel and steel pipe shell mean long, trouble-free equipment life even under severe operating conditions. Bulletin 122 gives you the whole story on Whitlock Lube Oil and Jacket Water Coolers. For your copy, just fill in and return the coupon today.



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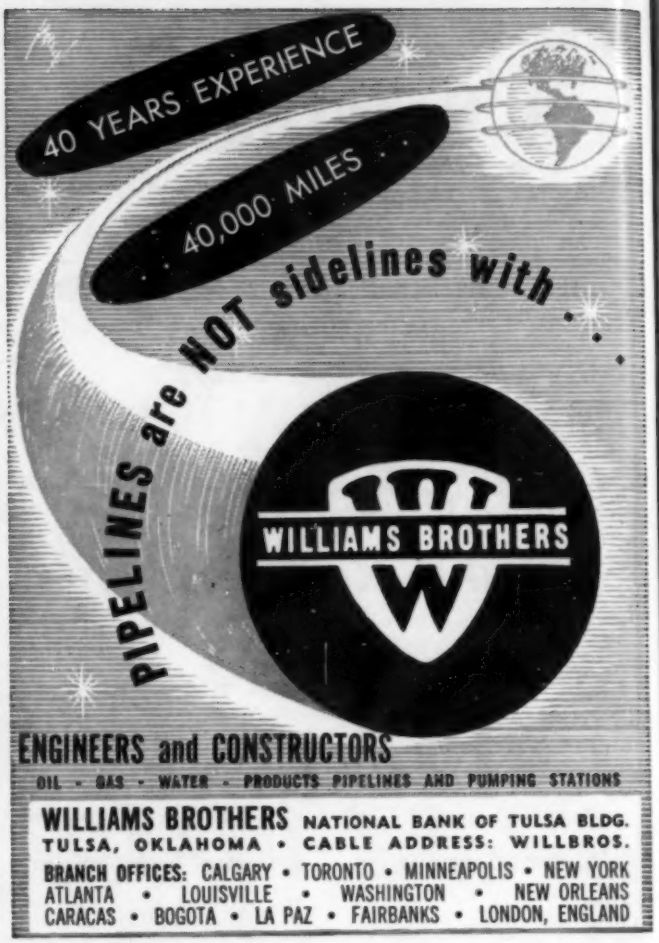
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New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

Sling Handbook

Several new developments in Tuffy slings have necessitated a new and expanded edition of Union Wire Rope's Sling Handbook. Foremost of new developments, according to Union Wire Rope engineers, is a streamlined, heavy-walled, steel ferrule eye splice. It is slipped on over a tuck splice of the machine-braided fabric of which Tuffy slings are made and then pressed on under such pressure that the metal of the ferrule virtually flows into the interstices of the fabric.

The 1955 Tuffy Sling Handbook contains 60 pages of illustrations, charts and diagrams describing 16 different factory-fitted slings and nearly two dozen standard fittings available for slings. Several of these slings are new types recently added to the Tuffy line. Many of the fittings—clamps, hooks, bridles, thimbles, saddles—are of new design and construction.

It contains a complete rigger's manual, shop chart of proof-tested ratings for all Tuffy slings, a new engineer's notebook and standard signals for directing the operations of overhead traveling cranes, cranes and derricks and locomotives.

To get a copy circle **No. E11** on Readers' Service Card, last page this issue.

Scraper Brochure

Engineering, design, construction and mechanical features of the new Allis-Chalmers motor scraper are outlined in the new catalog released by the Construction Machinery division. Photographs and drawings show the advances incorporated in the 20 cubic yard heaped or 15 cubic yard struck capacity motor scraper powered by the 280-horsepower Allis-Chalmers diesel engine. Operator comforts are outlined and complete specifications of the unit are included.

To get a copy circle **No. E12** on Readers' Service Card, last page this issue.

Forged Steel Valves

Edward Valves, Inc., subsidiary of Rockwell Manufacturing Company, has released a new bulletin on small Rockwell-Built Edward forged steel valves. The publication illustrates and gives details on Edward forged steel stop, stop-check and needle valves for a variety of applications.

To get a copy circle **No. E13** on Readers' Service Card, last page this issue.

Plastic Pipe Data

Southwestern Plastic Pipe Company has announced completion of two catalog inserts covering their Kralastic and Tenite plastic pipe. The new literature gives specific technical information on oil field applications of both types.

The Kralastic Catalog includes information on Southwestern's new pressure-rated Kralastic pipe complete with stock sizes and pressure-rated groups. Both the Kralastic and Tenite brochures outline chemical resistance and physical properties of each pipe along with tables and graphs of tensile strength versus temperature, limitations, etc.

To get a copy circle **No. E14** on Readers' Service Card, last page this issue.

Insulation Literature

The Silco-Flex all-silicone-rubber insulating system for motor and generator stator windings is the subject of a recent leaflet released by Allis-Chalmers Manufacturing Company. The leaflet explains why the insulation has superior electrical, thermal and mechanical properties as well as desirable chemical properties.

To get a copy circle **No. E15** on Readers' Service Card, last page this issue.

Vibration Monitors

A data sheet on The Beta Corporation's new electronic Vibraswitch has been released. Designed for use on large pump motors, diesels and gas engines, the new vibration monitoring instrument is also being used on test rigs, stationary gas turbines, centrifugals and rotary equipment to detect a malfunction and shutdown equipment before costly damage occurs. Applications, advantages and special features, description and operation, specifications and ordering information are included on the data sheet.

To get a copy circle **No. E16** on Readers' Service Card, last page this issue.

Fittings Manual

Detailed data on five Ladish Company fittings developments for pipe line and petroleum industry applications are included in a new manual recently released by the company.

Developments include hot tap reinforcing tees for improved reinforcement of horizontal or vertical pipe line branch connections; multiple outlet headers with seamless outlets to simplify design and reduce installation costs in gate settings and suction and discharge manifolds; extra long radius elbows to facilitate pipe line cleaning operations and minimize loss in flow efficiency; pipe line anchor flanges to provide positive means for restricting pipe line movement; and streamline design seamless multiple outlet headers to facilitate design, simplify and speed erection and improve efficiency of heater units.

Photographs, sketches and engineering drawings graphically demonstrate design advantages of the new fittings as well as savings in construction time and costs.

To get a copy circle **No. E17** on Readers' Service Card, last page this issue.

Compressor Brochure

A 125-horsepower electric-driven air compressor recently added to the Ingersoll-Rand line of air-cooled two-stage Type 40 stationary compressors is described in a brochure published by the company. Data on installation, operation and maintenance are included.

To get a copy circle **No. E18** on Readers' Service Card, last page this issue.

8

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Fig. 1

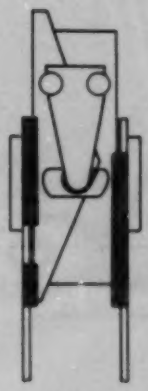

Fig. 2

Fig. 3

HERE'S HOW LEVERLOCK ASSURES POSITIVE, EASY OPERATION

The Leverlock holds the gate and segment in a neutral position while valve is being opened or closed — and permits expansion of the gate assembly for seating in opened or closed position.

Fig. 1 shows gate and segment in closed position. As the valve opens, the Leverlock arm swings to the right and travels between guides (Fig. 2) on the seat skirt. Since the arm cannot swing to the right or left, the gate and segment are held in a neutral position. When gate and segment reach open position, the Leverlock arm swings into a slot in the seat skirt (Fig. 3), permitting the gate and segment to expand against the seats.

W-K-M are the *only* Pipeline Valves with this positive mechanical means for easy operation . . . another of the reasons why most of the world's pipelines are tied together with W-K-M Valves.

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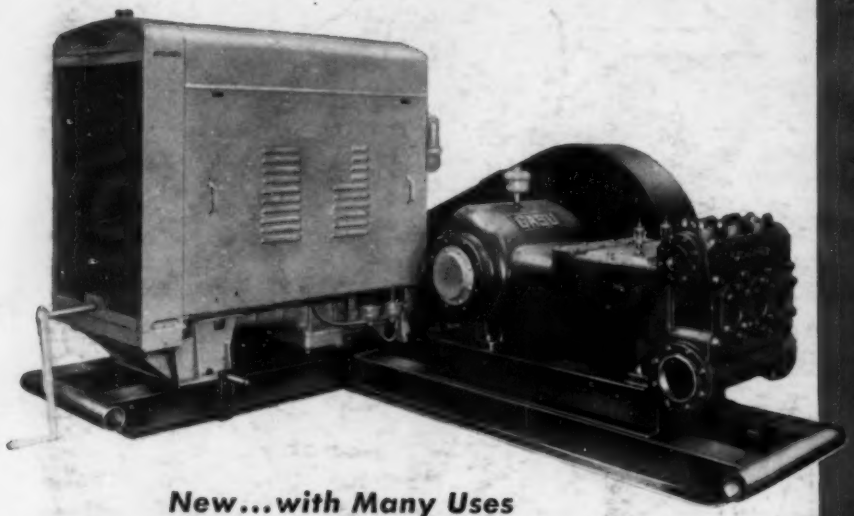

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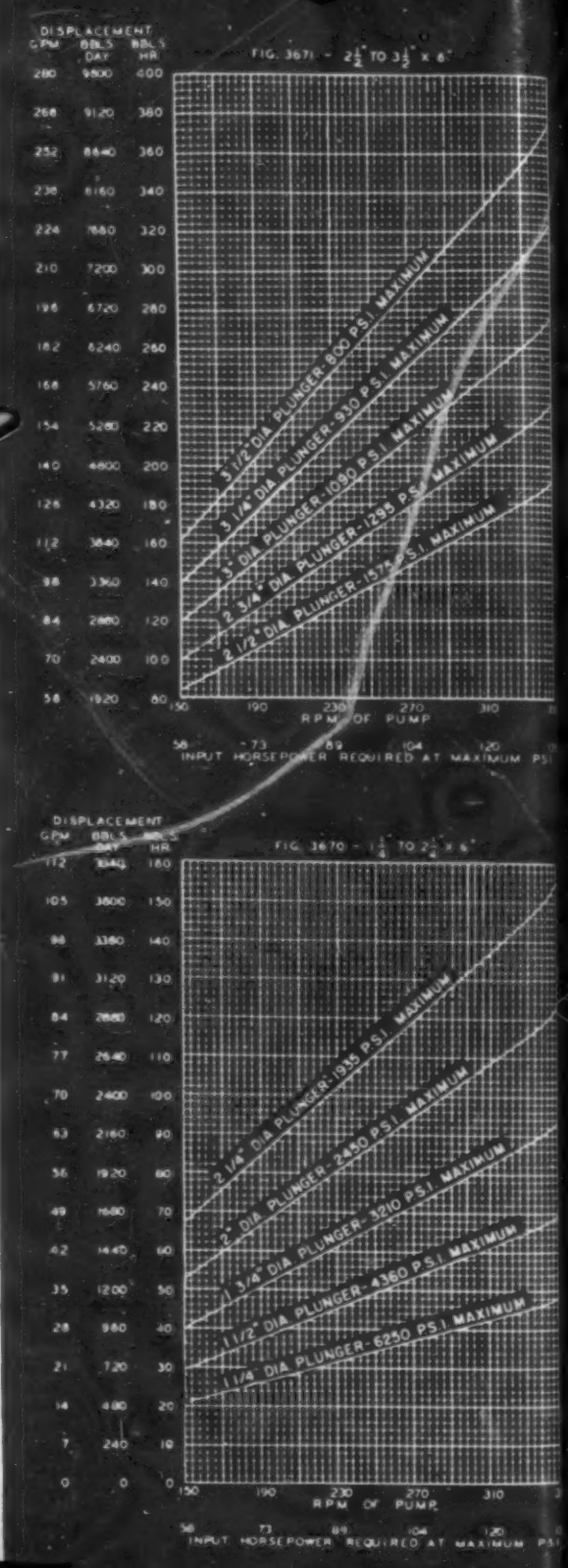

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